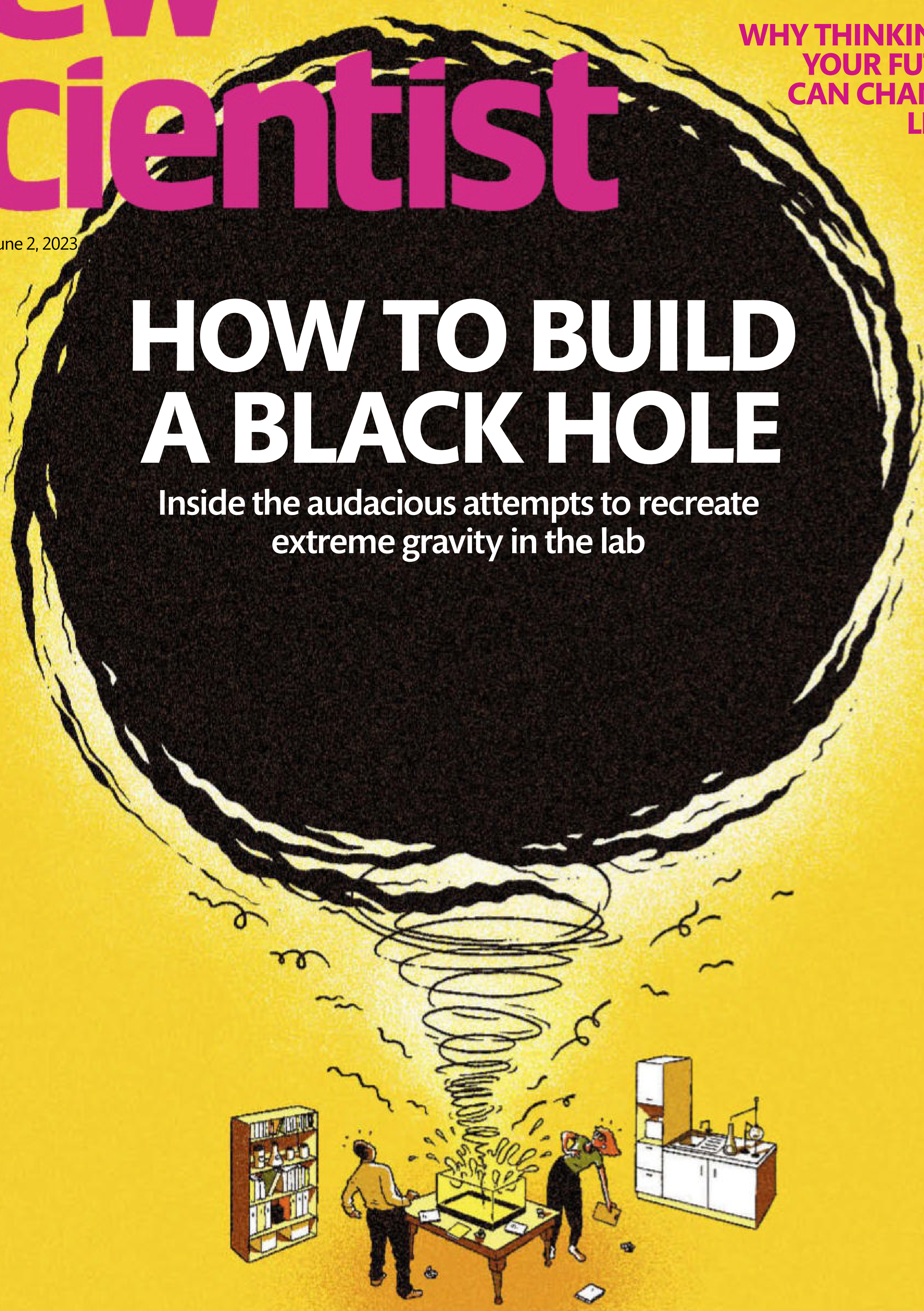
New Scientist

WEEKLY May 27-June 2, 2023

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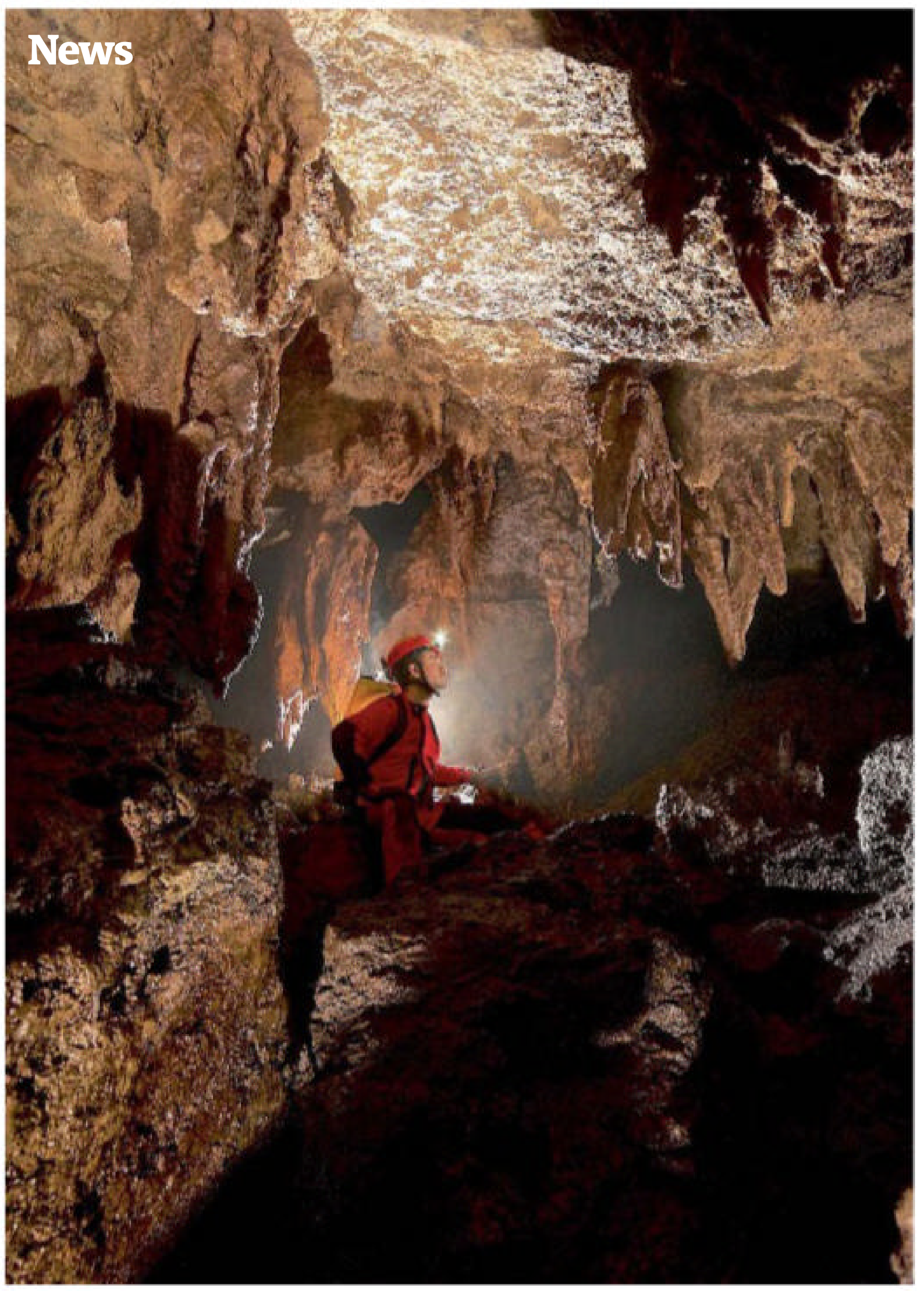
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Event

The Search for Dark Matter

Why do researchers believe in the existence of a substance we can't see and that no one has directly detected? Particle physicist Jocelyn Monroe and a panel of *New Scientist* journalists offer a deep dive into the science of dark matter. Join us at Conway Hall in London, or online, on 7 June at 7pm BST/2pm EDT. Tickets are free to this subscriber-only event.

newscientist.com/events

Tour

Total solar eclipse 2024: Houston to San Antonio

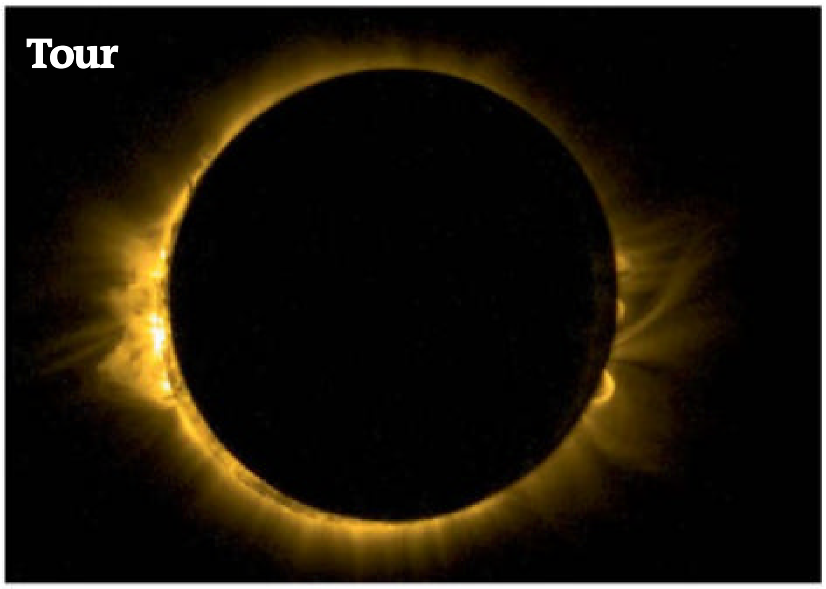
Reserve your front row seat for a solar eclipse that will be visible across North and Central America on 8 April 2024. You will view the astronomical event from a carefully chosen location in Texas in the company of astronomer John Mason and *New Scientist* features editor Abigail Beall. The eight-day tour also includes a visit to NASA's Space Center Houston. Tickets are £4399.

newscientist.com/tours



BRUCE THOMSON/NATUREPL.COM

Bacteria swap Kangaroos may help make beef better for the planet



ESA/ROB

Chasing shadows View a solar eclipse in Texas next year

Podcast

Weekly

Can we cut the gas emissions associated with beef by giving cows stomach bacteria from kangaroos? The podcast team investigates. There is also news of a special "quasiparticle" – the non-Abelian anyon – that keeps a record of its past, and that has been created using a quantum computer. Plus, how irregular sleeping patterns harm health.

newscientist.com/nspod

Video

Virtual touch

On our YouTube channel this week, you can see footage of smart gloves that give their wearer an enhanced sense of touch in virtual reality. Electrodes in each glove stimulate the backs of the hand and fingers, giving the wearer the illusion that they are touching something. Researchers tested the gloves on several VR experiences, including climbing a virtual rope.

youtube.com/newscientist

Newsletter

Health Check

There are new clues to the causes of Alzheimer's, writes health reporter Clare Wilson. The disease is typically thought to be due to a protein called amyloid, but a study of people in Colombia who are prone to developing Alzheimer's in their 40s hints that a different brain protein called tau is critical too.

newscientist.com/health-check

A note from the culture editor



Dear reader,
Exciting news. This week we are launching the New Scientist Book Club, a place to find out about the very best new science and science fiction offerings out there, and to talk about them with your fellow book lovers.

Every six weeks, we will choose a new title to read and discuss. Then, once we've got to grips with it, we will interview its author to dig into why and how they wrote it. We will also be bringing you extracts from our chosen books and insights into our authors' favourite reads and inspirations.

To kick things off, we will be homing in on science fiction with *The Ferryman*, a novel by the brilliant Justin Cronin. You may know him as the author of the post-apocalyptic vampire trilogy *The Passage*. His new book is something very different, set on an apparently utopian island where citizens live an idyllic life until they grow old, whereupon they are sent to a neighbouring island for a reboot, and start life afresh.

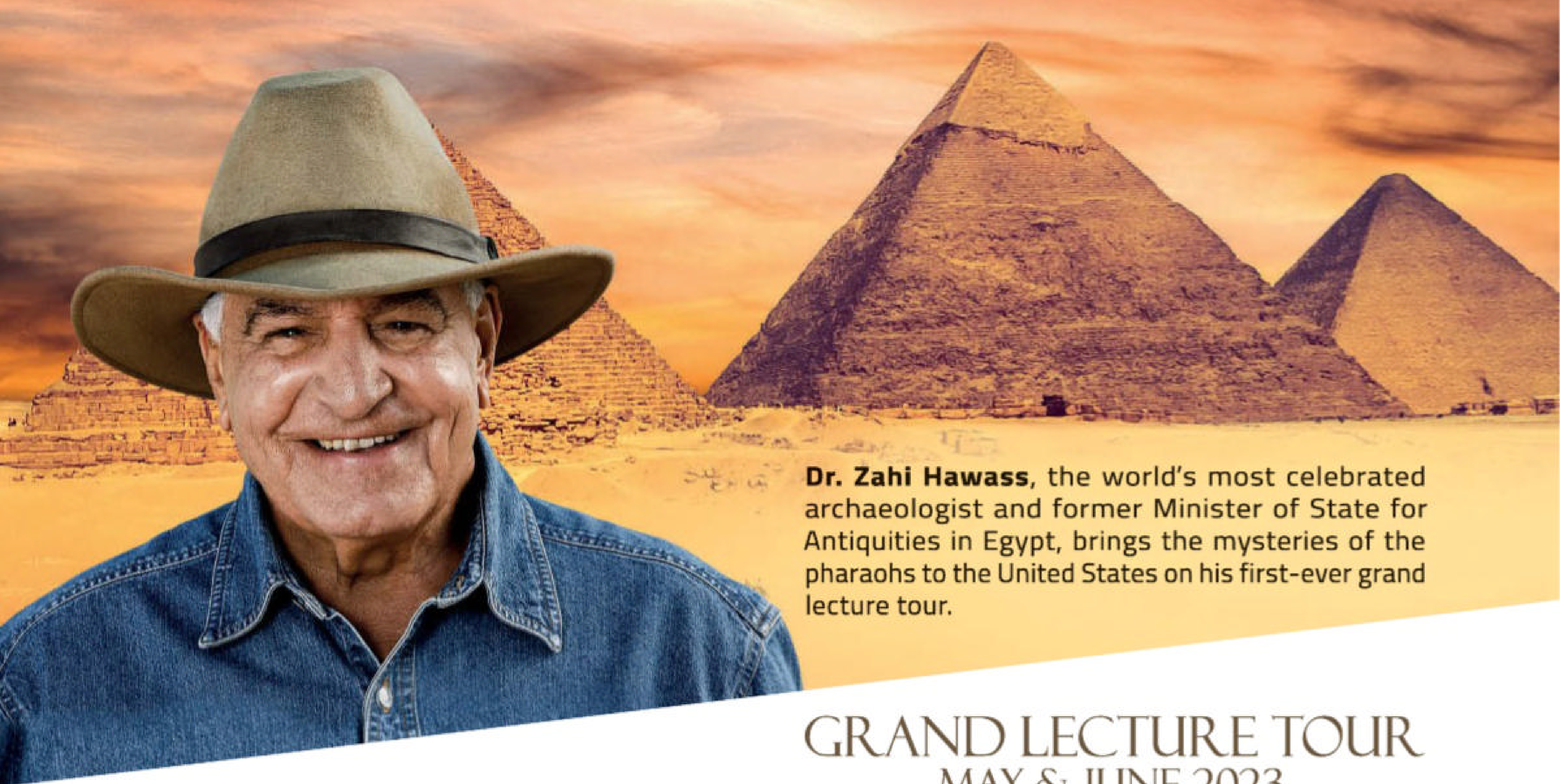
You can read our review of *The Ferryman* on page 34. I loved it, in particular the blinder of a twist Cronin hits readers with – and I am itching for the chance to discuss it with others. So sign up at newscientist.com/bookclub, grab a copy, and get reading!

Alison Flood
New Scientist comment and culture editor

SECRETS OF ANCIENT EGYPT – NEW DISCOVERIES

AN EVENING WITH DR. ZAHI HAWASS

THE WORLD'S MOST FAMOUS ARCHAEOLOGIST



Dr. Zahi Hawass, the world's most celebrated archaeologist and former Minister of State for Antiquities in Egypt, brings the mysteries of the pharaohs to the United States on his first-ever grand lecture tour.

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The cosmos in a teacup

Physical imitations of extreme astrophysical phenomena are genuinely useful

ANALOGIES have always been helpful in our attempts to make sense of an enigmatic universe. Perhaps the best-known example is space-time, which is often likened to a malleable sheet underlying everything. Massive things like planets depress the sheet, such that less massive things – people, asteroids and so on – tend to fall inwards. It isn't a perfect analogy, of course, but it allows those of us who can't read the equations of general relativity to grasp the nature of reality.

In recent years, researchers have been using fluids and collections of cold atoms as space-time equivalents. These aren't just verbal analogies. They are physical imitations, or "analogues", that purport to exhibit space-time phenomena in ways you can see and touch. Some of these phenomena – such as black holes and cosmic inflation, thought to have driven the exponential expansion of the universe after the big bang – have never been detected directly astronomically.

As we explore in our feature on page 38, the idea is that analogues can help us to better understand the behaviour of extreme objects or events we can never hope to directly observe. The question is, if you confirm a prediction in a laboratory analogue, are you also confirming it for the system the analogue is supposed to represent?

"Analogues can help us better understand extreme objects we can never directly observe"

Many physicists think not. After all, an analogue black hole might consist of a few waves in a water tank, whereas a real black hole would rip you apart. They simply aren't the same thing, and you can't glean insights from one about the other.

What this view ignores is the surprising similarities between analogues and the real things they represent. At the very least, then, testing the strength of the relationship between analogue and real space-time could clarify how we think about hypothetical phenomena.

But some physicists believe that space-time has more in common with everyday stuff than we tend to assume. If so, the implications for our understanding of the cosmos could be vast – and the study of analogue cosmology entirely justified. ■

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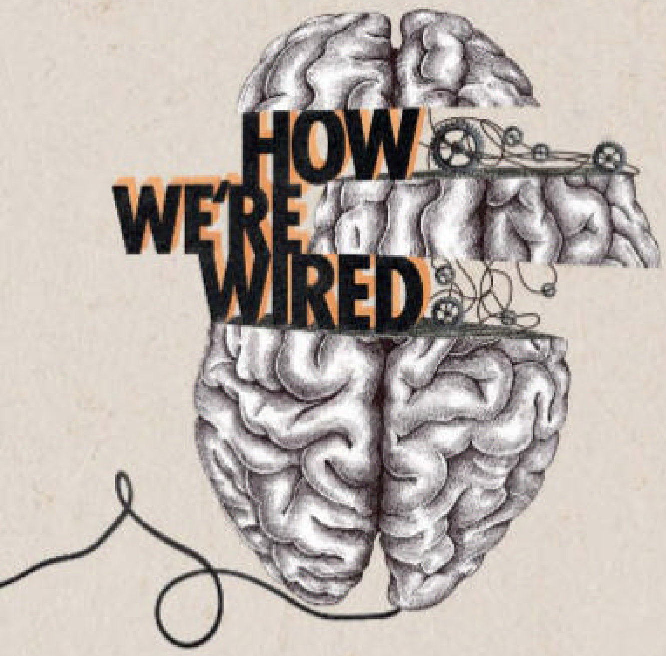
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News

Covid-19 boosters
Crucial change would help vaccines tackle new variants **p8**

Thar she blows
Bowhead whales' secret weapon against cancer **p10**

Grass not greener
US desert grassland collapse is linked to Pacific changes **p11**

Future computing
'Memcomputer' could trump standard machines **p13**

Ancient blueprints
Stone Age carvings are oldest known architect's plans **p19**



Life

An eye-catching jewel of nature

This vivid lizard is a male Cambodian blue-crested agama (*Calotes goetzi*). The species mainly eats insects and can change colour when guarding its eggs. It is one of a cornucopia of 380 newly identified animal and plant species from Cambodia, Laos, Myanmar, Thailand and Vietnam, according to a report by environmental charity WWF.

HENRIK BRINGSOE

Coronavirus

Covid-19 vaccine tweak could better tackle today's variants

Michael Le Page



CHARLOTTE TATTERSALL/GETTY IMAGES

New covid-19 booster shots will need to focus on the latest variants

VACCINE-makers should stop including the spike protein of the original SARS-CoV-2 coronavirus in covid-19 booster jabs to make them more effective against current variants, a study of antibody responses has concluded.

The first covid-19 vaccines were based on a SARS-CoV-2 genome sequence from Wuhan, China, made public on 11 January 2020. From this, researchers determined the sequence of the spike protein on the outside of the virus and started creating vaccines based on it. Moderna had the first doses of its mRNA vaccine ready for testing by 24 February 2020.

But by the time the first vaccines were approved and vaccination campaigns got under way near the end of 2020, new SARS-CoV-2 variants were emerging. These had mutations that changed the shape of key parts of the spike protein, so antibodies targeting the original didn't bind to it as well.

This reduced the vaccines' effectiveness at preventing infections, although they remained highly effective at preventing serious disease. After the omicron variant emerged with even more changes towards the end of 2021, vaccine-makers began to prepare booster vaccines based on the omicron spike protein.

When vaccines such as annual flu jabs are updated, they normally contain only the new variant or variants. But vaccine firms made "bivalent" covid-19 booster vaccines containing both the original and omicron spikes, mainly because of regulations making it simpler to get approval for such boosters, says Aubree Gordon at the University of Michigan.

There has been debate about whether bivalent boosters are better than monovalent boosters containing only the original spike. Recent studies suggest that bivalent boosters do provide substantially more protection against severe disease – but aren't much better at preventing infections.

Gordon's team has now looked at the antibodies produced by 72 people who, after their first three vaccine doses, got either a monovalent booster, a bivalent booster or an omicron infection. The team found that the types of antibodies produced in response to the bivalent booster were similar to those appearing after a monovalent vaccine, and were still focused on the original spike (bioRxiv, doi.org/kbrw).

> **"The original vaccine is essentially for an extinct virus not seen on the planet since 2021"**

By contrast, in those infected by omicron, there was a shift in focus, with more new antibodies specifically targeting the omicron spike protein.

This is an example of "immunological imprinting", says the team. When the original spike is present, people's immune systems are revving up the pre-existing response to that protein, instead of producing new antibodies that target the changed spike.

"It's a good study," says Danny Altmann at Imperial College London. The original spike vaccine is "essentially a vaccine for an extinct virus not seen on the planet since 2021".

The World Health Organization has come to the same conclusion based on related findings. In a statement on 18 May, the WHO "advises moving away from the inclusion of the index [original] virus in future formulations of COVID-19 vaccines". The WHO is recommending that new vaccines should be based on the XBB.1 omicron subvariants now dominant around the world.

The US Food and Drug Administration is due to meet on 15 June to decide what should be in the next US covid-19 boosters. ∎

Cryptocurrency

Ethereum's energy-saving update also closed security flaw

Matthew Sparkes

WHEN the world's second-largest cryptocurrency, Ethereum, slashed its energy use by changing how it worked last year, it also sidestepped a serious security flaw. However, at least one cryptocurrency that "forked" from Ethereum by copying its code is still at risk.

Ethereum used to rely on "proof of work" to secure its network, as bitcoin still does, in which computers perform huge numbers of calculations to "mine" new currency and verify transactions. But in September 2022, Ethereum switched to a technique called proof of stake. That switch – known as the Merge – reduced energy consumption by 99.99 per cent.

Massimiliano Taverna and Kenneth Paterson at ETH Zurich in Switzerland discovered a security flaw at about the time of the Merge. It concerns software called Go Ethereum, a popular tool used to run Ethereum nodes. Running a node allows you to create transactions and broadcast them across the network. Versions of Go Ethereum have been adapted by Ethereum Classic and EthereumPoW, two cryptocurrencies based on the old Ethereum code that still use proof of work.

A hacking attack described by Taverna and Paterson could have been launched "against a node in Ethereum with just five [graphics processing units], which you can buy for $1000", says Taverna. The Merge rendered Ethereum safe.

Developers at Ethereum Classic patched what they called a "legitimate vulnerability" after Taverna and Paterson warned them. EthereumPoW, which has a total value of some $226 million, is still vulnerable, say the two experts. "We tried to contact them multiple times, but they unfortunately didn't reply," says Taverna.

EthereumPoW and Go Ethereum didn't respond to *New Scientist*'s request for comment. ∎

Quantum mechanics

Fundamental physics law tested

A concept known as the principle of least action has finally been seen in the quantum realm

Karmela Padavic-Callaghan

A CENTURIES-OLD fundamental law of physics known as the principle of least action has been demonstrated using quantum objects for the first time.

"A physicist's ultimate dream is to write the secrets of the entire universe on a small piece of paper and the principle of least action must be on the list," says Shi-Liang Zhu at the South China Normal University.

This foundational concept generally requires that objects behave simply and efficiently, like light travelling between two points in a piece of glass along the quickest path.

According to the principle, to determine what trajectory any object will take between two points in space and time, you need to calculate a quantity called action, which is often related to energy and momentum. The trajectory that has the minimal action is the one the object will end up taking.

For ordinary objects, this is verified by recording the path taken. But in the quantum realm, odd properties of entities – like simultaneously being particles and waves – typically make it impossible to determine the exact trajectories of objects.

This is why the quantum version of the principle of least action, as proposed by Richard Feynman in the 1940s, is formulated in terms of wave functions and propagators, both abstract mathematical concepts.

The wave function of a quantum particle of light, or photon, mathematically describes its quantum state, while a propagator predicts how a wave function changes as a photon travels from a start point to an end point.

Despite this complexity, in 2011, a team demonstrated a way to measure a photon's wave function, translating its abstract imaginary numbers into measurable quantities like the polarisation of light. Zhu and his colleagues have now built a more complex experiment in which photons moved through a maze of mirrors, lenses and crystals, which manipulated their properties.

"A physicist's dream is to write the secrets of the entire universe on a small piece of paper"

By the time photons reached the end, their measurable properties corresponded to imaginary parts of their wave functions and propagators. From readings of detectors and cameras, which recorded things such as the polarisation and position of each photon, the team reconstructed wave functions at different points in the maze and the propagators responsible for differences between those wave functions.

This gave Zhu and his team the ingredients to test the quantum version of the principle of least action in several scenarios. One was the quantum equivalent of a ball rolling on frictionless level ground and the other was akin to a ball stuck at the bottom of a bowl. Their calculations of what photons should do based on the principle returned the same results as calculations of what they did do based on their measurements (*Nature Photonics*, doi.org/kbsq).

"It is beautiful to see this theory made real in an experiment," says Jonathan Leach at Heriot-Watt University in the UK. ■

Geology

Bat guano has sculpted caves for thousands of years



ATALIBA COELHO

An iron ore cave in Carajás National Forest, Brazil, that was once inhabited by bats

IRON ore caves in Brazil where bats roost are much larger than caves without bats – at least partly due to the effects of thousands of years of guano, or faeces.

The iron-rich earth beneath the Carajás National Forest in the Brazilian Amazon hosts more than 1500 caves, only 10 of which currently house bats or used to.

Most cave-dwellers – such as bacteria, fungi and invertebrates – stay underground. But bats forage outside and much of the organic matter they consume ends up in the cave in their guano, says Enrico Bernard at the Federal University of Pernambuco in Recife, Brazil.

He and his colleagues noticed that caves with bats were larger and had more formations like stalactites and stalagmites. They wondered if bats played a role in carving the caves, or just choose big caves.

Their analysis shows that, on average, bat caves were nearly 200 metres long – while regular caves were only 30 metres long – and had volumes five times larger.

With colonies sometimes exceeding 150,000 bats, the guano piles up. "Some of these deposits are 1 metre deep," says Bernard.

Sampling the water that seeps through these caves, the researchers found that faeces make a slew of acids that can dissolve the iron. Radiocarbon dating at different depths of a guano pile revealed that bats have been using the same caves for millennia. The oldest was from around 22,000 years ago (*PLoS One*, doi.org/kbrm).

The way acid etches caves out of iron ore seems surprisingly similar to how limestone caves are formed, says Philippe Audra at the Côte d'Azur University in Nice, France.

An outcry halted a move last year to open protected caves to mining, but the threat remains as mining companies want to quadruple the area available for extraction in the Carajás, says Bernard. ■

Carolyn Wilke

Life

Bowhead whales' cancer secret

Their cells are very good at repairing DNA, which may explain the mammals' lasting health

Carissa Wong

BOWHEAD whales, the world's longest-lived mammals, are seldom affected by cancer and this may partly be because their cells repair damaged DNA efficiently.

Large animals have more cells than smaller ones, so they should be more likely to get cancer, but this doesn't seem to be the case. This unexpected phenomenon is known as Peto's paradox.

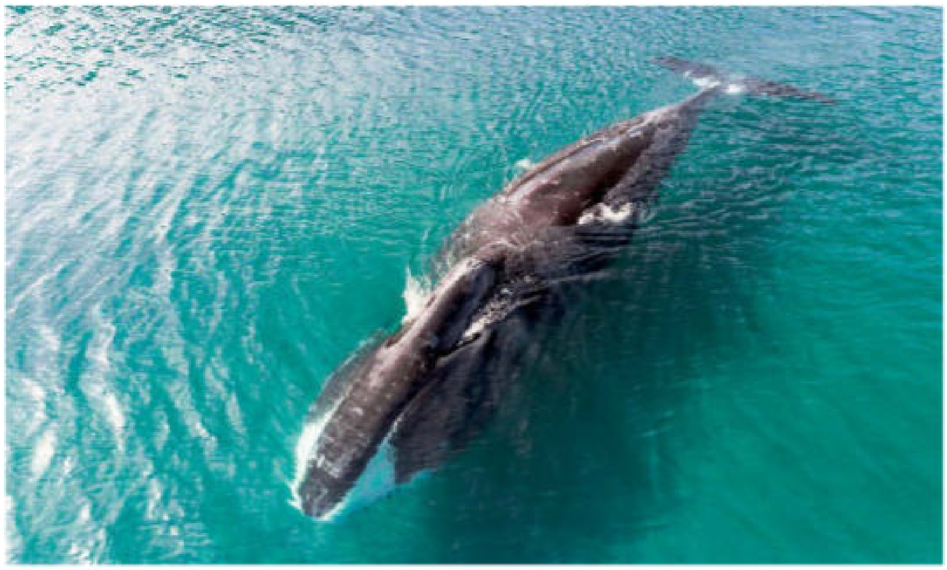
In fact, many massive animals have very low rates of cancer, including bowhead whales (*Balaena mysticetus*), which can weigh more than 80,000 kilograms and live for over two centuries. Last year, a study found that one possible reason for this is that bowhead whales have more copies of genes that suppress the development of cancer.

Now, Vera Gorbunova at the University of Rochester in New York and her colleagues have studied how well skin cells from different animals repair a type of genetic damage in which both strands of the DNA molecule are broken. Such "double-strand breaks" are known to increase the risk of cancer.

To do this, the researchers used an enzyme to create double-strand breaks in cells from humans, cows, mice and bowhead whales. They also inserted a gene into the cells that produced a fluorescent green protein following repair of the damaged DNA.

By imaging the cells, the researchers found that more than twice as many of the damaged bowhead whale cells repaired the breaks in DNA compared with human, cow and mouse cells.

Bowhead whales can live for more than 200 years



NATURE PICTURE LIBRARY/ALAMY

What's more, the human, cow and mouse cells most often deleted several DNA letters during the repair process, but, for the most part, bowhead whale cells accurately repaired the DNA or introduced just a single DNA letter during repair. Adding or deleting letters changes the DNA sequence, which means a gene may not function properly and this can lead to cancer.

The researchers also found that a protein called CIRBP, which is involved in repairing DNA, was at higher levels in the bowhead whale cells than it was in human, cow and mouse cells.

To test whether this might increase the efficiency of DNA repair, Gorbunova and her colleagues genetically modified human and mouse cells to produce high levels of the version of CIRBP found in bowhead whales. The tweaked cells were able to repair double-strand breaks about twice as well as ordinary cells (bioRxiv, doi.org/kbrj).

"This is an excellently done study," says Antonello Lorenzini at the University of Bologna in Italy. "If we can regulate, somehow, our own CIRBP protein, that could absolutely be a strategy to reduce DNA damage in humans."

However, experiments in cells aren't sufficient to understand the mechanisms of cancer, says Angelo Fortunato at Arizona State University. "Because it attacks the very essence of multicellular organisation, the discoveries obtained from genetic or cellular studies must be validated at the organismal level." ■

Earth science

Volcano eruption disrupted satellites on far side of planet

A MASSIVE volcanic eruption in Tonga last year was so powerful it affected satellites on the other side of the world. Similar events could cause dangerous interference in the future unless we learn to better predict such activity.

GPS satellites have long been known to be vulnerable to an effect called equatorial plasma bubbles (EPB). These are areas of low pressure that form and rise like bubbles through the atmosphere. During daylight, the sun's rays ionise the highest part of the atmosphere – a layer called the F region, 150 to 800 kilometres above Earth's surface.

When night falls, these ions recombine and can form EPBs that affect the transmission of radio waves through the atmosphere, which carry GPS signals. Scientists have previously found that EPBs can also be formed by winds, and have long theorised that they are also formed by volcanic activity. "We could not link them definitively in the past," says Atsuki Shinbori at Nagoya University in Japan.

But the eruption of the Hunga Tonga-Hunga Ha'apai volcano in January 2022 has changed things. It created tsunamis 90 metres high and shot ash 57 kilometres into the sky. There was a degradation of GPS signals at the time of the Tonga eruption, and Shinbori and his colleagues have now analysed data to prove a correlation. This shows that the eruption disrupted satellite communications thousands of miles away.

57km

The height reached by ash from the Hunga Tonga-Hunga Ha'apai volcano

They used data from the EPB-detecting Arase satellite, the Himawari-8 satellite that monitors air pressure waves and ground-based ionospheric observations. They found evidence of EPBs in equatorial to low-latitude Asia after the arrival of pressure waves generated by the volcanic eruption (*Scientific Reports*, doi.org/gr84b9).

Shinbori says better prediction of volcanic activity is vital to mitigate satellite disruption. ■

Matthew Sparkes

Health

CRISPR-edited cells could help with chronic heart failure

Carissa Wong

A DOSE of CRISPR-edited heart cells has boosted the survival of rats with chronic heart failure and increased how much they exercised. Tests of the technique in humans could happen within a few years.

Chronic heart failure, where the heart fails to pump blood effectively around the body, is a leading cause of death worldwide. For most people, this condition – involving slow, weak heart contractions – can't be cured, but its symptoms are treated using drugs to widen blood vessels and reduce blood pressure.

Now, Charles Murry at the University of Washington in Seattle and his colleagues have modified human heart cells using CRISPR gene editing to produce high levels of a molecule called dATP, which helps heart cells contract faster and stronger.

To test the cells, the researchers turned to rats that had surgically induced heart injuries to mimic chronic heart failure. After three months, all 16 rats injected with the gene-edited heart cells were still alive and about 90 per cent of 14 rats treated with unedited heart cells had survived. Just 60 per cent of 10 rats that received no cells survived (bioRxiv, doi.org/kbrc).

"The gene-edited cells tackle two root causes of heart failure by, firstly, partially replacing dead heart cells at the site of injury and, secondly, by boosting contractions in surviving heart cells across the heart by manufacturing dATP," says Murry.

In a 12-hour period at the end of the experiment, rats treated with the gene-edited heart cells also ran nearly twice as far on a wheel as those given unedited heart cells, and roughly three times as far as the control group of rats.

The cells should last for the life of an animal or patient, says Murry, who thinks trials to determine if the findings can be replicated in humans could start in 2025. ▮

Environment

US desert grassland collapse is linked to Pacific changes

James Dinneen

THE boom and bust cycles of desert grasses in the US Southwest are linked to temperature patterns in the Pacific Ocean, but that link now seems to have been broken by climate change. This could complicate efforts to restore the grasslands.

The Chihuahuan desert extends from the US Southwest into Mexico over more than 500,000 square kilometres. It contains some of the most biodiverse grasslands in North America, across which perennial grasses are locked in a battle with woody shrubs for water and space. The grasses regularly spread and die back in cycles of collapse and recovery.

Brandon Bestelmeyer at the US Department of Agriculture and his colleagues took data from 1916 to 1979 on grassland cover and make-up of species over 86 square kilometres at a research plot in New Mexico. They then modelled how well climatological factors could explain grassland changes.

Chihuahuan desert grassland in the far west of Texas



LUC NOVOVITCH/ALAMY

Local records of temperature, precipitation and drought couldn't predict changes in the area covered by grassland, says Bestelmeyer. Rather, the spread of grasses in this period was correlated with a 40 to 60-year cycle of sea surface temperature known as the Pacific Decadal Oscillation (PDO).

"These are systems that have changed really dramatically over the last 150 years"

The PDO can influence the climate of distant regions, as air cooled or warmed over the north-east and tropical Pacific Ocean affects wider patterns of atmospheric circulation.

Grass cover was highest during the PDO's warm phase, which is generally associated with wetter years in the Chihuahuan desert region. During the cool phase, grasslands collapsed, notably during a severe drought in the late 1940s. The researchers found a similar pattern occurred in several other grasslands in the region, though not all (*Ecology*, doi.org/kbq2).

Bestelmeyer says one explanation for why the PDO can account for changes is that focusing on its influence integrates many factors that can't easily be measured locally, such as cloud cover or small changes in precipitation.

Another explanation is that desert plants tend to be less sensitive to short-term changes in precipitation and heat, and more sensitive to a long-term "accumulation" of changes, says Andy Kleinhesselink at the University of California, Los Angeles. "They're stoic plants."

However, after 1979, the link between grasslands and the PDO seems to have broken down. Since then, grassland cover has remained persistently lower than the researchers' model would predict based on the influence of the PDO, which entered a warm phase between 1977 and 1998. Measurements of grassland cover since 2000 have included some of the lowest points in the past century.

This change could be due to increased evaporation and stresses from warming or the success of encroaching woody plants such as mesquite trees, which are more resilient to drought than grasses, says Bestelmeyer. A megadrought has affected the south-west region since 2000.

Human-linked activity such as agriculture and livestock grazing have also altered the grasslands, says Heather Throop at Arizona State University. "These are systems that have changed really dramatically over the last 150 years."

If the breakdown of the link between grassland and the PDO is due to hotter temperatures, Bestelmeyer says grasslands could have trouble recovering. ▮

News

Marine biology

Octopuses may have nightmares about being attacked by predators

Michael Le Page

STRANGE behaviour displayed by a sleeping octopus hints they have nightmares, says Marcelo Magnasco at the Rockefeller University in New York.

In 2021, his team acquired an octopus (*Octopus insularis*) to study cephalopod cognition. The octopus, named Costello, rapidly adapted to captivity and began sleeping out in the open, rather than in a den as octopuses do in the wild.

One morning, team member Eric Ramos, also at Rockefeller, entered the room with the aquarium and noticed that the water was cloudy with ink. So he checked the camera footage.

It showed that Costello had been sleeping quietly in the tank that he shared only with tiny fish. For no apparent reason, he suddenly began thrashing around, tried to make himself look bigger by extending his mantle into a cone shape and released ink, as if he were being attacked by a predator (bioRxiv, doi.org/kbqr).

"If you admit that an invertebrate can have dreams, then a nightmare is a no-brainer," says Magnasco. "The life of an animal in the wild can be hard."

Before being caught, Costello had lost one of his tentacles to a predator. "He had a rough life," says Magnasco.

When the team looked through hundreds of hours of footage of Costello, they found three similar, but shorter, events.

It remains unclear whether octopuses do dream in the same way that we do, says Magnasco. While sleeping, their skin usually goes pale and they remain motionless. But for short periods, their skin colours change while they are sleeping.

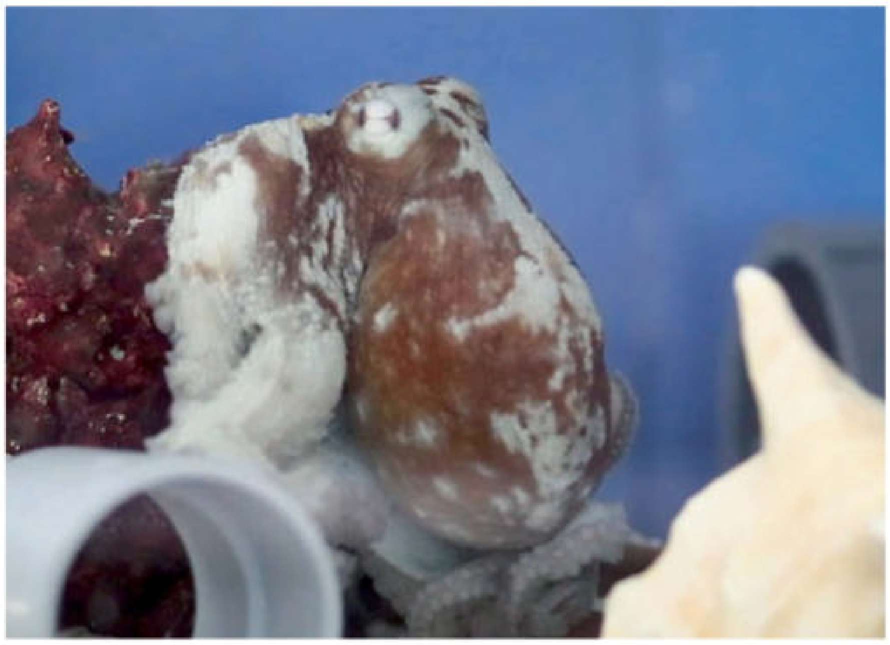
A 2021 study of common octopuses (*Octopus vulgaris*) by Sidarta Ribeiro at the Federal University of Rio Grande do Norte in Brazil and his colleagues showed that this colour-changing phase occurs every half an hour or so during sleep, and lasts 1 or 2 minutes. As well as the animals' skin changing colour and texture, their eyes and tentacles move.

This means it resembles the rapid eye movement (REM) sleep stage during which people dream. But monitoring octopuses to see if their brain activity is similar, too, is difficult. "Where do you put the electrodes on an animal that has no shape?" says Magnasco.

"If you admit that an invertebrate can have dreams, a nightmare is a no-brainer"

Even if cephalopods do dream, another big question is whether their dreams have narrative structures – that is, whether they imagine some sequence of events.

In a 2020 documentary, David Scheel at Alaska Pacific University noted that a sequence of colour changes his pet octopus, Heidi, exhibited while sleeping resembled those she displayed if capturing crabs and speculated that this is what she was dreaming about.


MARCELO O. MAGNASCO ET AL. (2023)

Costello is at an aquarium at the Rockefeller University in New York

Costello's anti-predator responses occurred just after this colour-changing sleep stage. His behaviour could be a form of sleepwalking, or parasomnia, says Magnasco. It might also be related to ageing – Costello was old in octopus terms at the time. No conclusions can be drawn from a few episodes in one animal, says Magnasco, and there may be other explanations.

"Albeit speculative, I think that the nightmare hypothesis is not unlikely and does deserve further investigation," says Ribeiro.

If narrative dreams have independently evolved in cephalopods, it suggests they are essential in advanced brains, says Magnasco. "It means it really is a strong requirement for some cognitive purpose." ■

Technology

Software update could give wind farms a big boost

Matthew Sparkes

A SIMPLE software upgrade could improve the efficiency of wind turbines by ensuring they face directly into the wind more of the time. If used worldwide, the technique could boost electricity production by 5 terawatt-hours a year – about the same amount as is consumed annually by Albania or 1.7 million average UK homes.

Wind turbines work most efficiently when directly facing oncoming wind. Current algorithms track wind patterns and adjust the turbine blades to anticipate changes, but Alban Puech and Jesse Read at the Polytechnic Institute of Paris believe artificial intelligence can do better. They have trained a reinforcement-learning algorithm to monitor wind patterns and develop its own strategy to maintain the angles of turbines.

The researchers ran simulations testing the same wind conditions on wind turbines running different control algorithms. They found that the AI algorithm aligned their simulated version of a REpower MM82 2-megawatt turbine more efficiently than a conventional one.

The AI moved the turbine more often, but saved power and kept the time spent readjusting to only 3.7 per cent. The AI model produced power gains of 0.4 per cent, and still offered an advantage of 0.3 per cent once the extra energy spent moving the turbine was taken into account (arXiv, doi.org/kbqw).

If applied to all wind turbines in the world, this would equate to boosting their combined electricity production by 5 terawatt-hours annually, say the researchers.

"The 0.3 per cent is important," says Simon Hogg at Durham University, UK. "Wind farm companies are interested in chasing the 0.1 per cents, the 0.3 per cents. It could be the difference between them having the revenue to develop the next one or not." ■

Technology

Meet the memcomputer

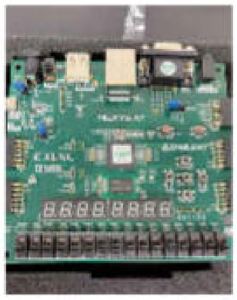
Proof-of-principle digital device shows it could trump standard machines

Matthew Sparkes

THE first practical example of a new kind of computer can complete calculations in minutes that would take a normal version longer than the age of the universe. This so-called digital memcomputer, which combines data storage and processing into a single component, could be a solution to the slowing pace of progress in traditional computer chips.

Theoretically, ordinary computers can solve any computational problem by performing single logical operations in a processor, storing the result in memory, then moving on to the next operation until the calculation is complete. In practice, this shuttling of data between components means some calculations take an impractically long time.

Memcomputers offer an alternative approach, using a single type of component called computational memory that handles both processing and memory functions at once. Many of these can operate in parallel, rapidly working together to find a solution. The downside is that memcomputers aren't general-purpose problem-solvers, but must be designed to handle specific calculations.



CHUNG NGUYEN

A team of researchers has made a memcomputer with a standard Nexys A7 circuit board like this

Until now, those designs have been analogue, with computational memory units storing data as electrical signals of varying voltage. While these circuits were able to solve problems, tiny variations in these voltages meant that scaling them up also scaled up noise and quickly rendered outputs meaningless.

Now, Massimiliano Di Ventra at the University of California, San Diego, and his colleagues have constructed a digital memcomputer. It uses binary numbers to store data and the researchers believe it can be scaled-up to handle practical tasks (arXiv, doi.org/kbqv).

The team's version is designed to solve a combinatorial problem common in standard computer chip design. "These are really tough problems," says Di Ventra.

A standard computer would need to methodically work through vast numbers of potential solutions sequentially until it stumbled across the correct one, but the memcomputer can find a solution in minutes. "It would take over the age of the universe if you actually did it with standard algorithms," says Di Ventra. "There's no way you can do it."

"Since the 1960s, computational power has been largely driven by the ability to fit in more and more transistors," says Neil Kemp at the University of Nottingham, UK, but chip designers are now reaching the limits of what is physically possible.

"Computing has become a little bit cleverer in terms of looking at new architectures and not being driven just by making transistors smaller and smaller,"

"It would take longer than the age of the universe if you cracked this problem with standard algorithms"

he says, adding that if research continues apace, then all computers could one day have dedicated memcomputing chips to handle certain tasks.

"It's under the radar a little bit at the moment, but we've solved a lot of very tough problems," says Di Ventra. "We're interested only in really tough problems, because for simple ones you can always use standard algorithms." ■

Botany

Rare plant turns carnivorous when low on phosphorus

A CLIMBING vine from West Africa can become a meat-eater when it doesn't get enough nutrition from the soil.

The liana *Triphyophyllum peltatum* grows in moist, forested hillsides in coastal regions of Sierra Leone, Liberia and Ivory Coast.

While some plants are fully carnivorous, *T. peltatum* is the only one known to be a part-time carnivore. It can unfurl special leaves with glands oozing sticky droplets that trap beetles and other insects, but until now it was unclear what conditions gave rise to this.

The liana also produces two types of non-carnivorous leaf, including ones with hooks on their tips that help it to climb.

Now, Traud Winkelmann at Leibniz University Hannover in Germany and her colleagues have managed to grow hundreds of young plants in vessels of fluid containing different concentrations of nutrients.

The team tested factors including temperature stress, treatments with stress-related hormones, and growth media that lacked one of the major nutrients – nitrogen, phosphorus or potassium.

Only plants starved of phosphorus grew carnivorous leaves. If these plants were transferred back into a control medium, new leaves emerged without the insect-trapping glands.



TRAUD WINKELMANN/UNIVERSITY OF HANNOVER

Sticky glands appear on leaves of this liana when the plant turns carnivorous

When dozens of the plantlets were transferred to pots of soil in a glasshouse, phosphorus deficiency in the soil also triggered the emergence of carnivorous leaves among them (*New Phytologist*, doi.org/gr8j57).

"Nutrient deficiency was one of the rather-to-be-expected factors, but we and others were expecting nitrogen [deficiency] to be more likely," says Winkelmann.

Carnivory may be an important survival mechanism in the plants' native mountain slopes where the shallow, acidic soils become depleted of nutrients, especially phosphorus, at the end of the equatorial monsoon rains in September, she says. ■

Ryan Truscott

Health

Has Alzheimer's met its match?

Antibodies that bind to a culprit protein have been hailed a "momentous breakthrough", but do they live up to the hype, asks **Clare Wilson**

JUDGING by some recent newspaper headlines, the prospects of an effective treatment for Alzheimer's disease have never been better. In the past couple of years, positive trial results have been announced for three drugs that clear a protein called amyloid – which is thought to play a crucial role in this form of dementia – from the brain.

But not everyone is convinced. Sceptics point out that these treatments won't have much impact on symptoms. They can also cause dangerous brain bleeds or swelling and aren't practical for widespread use.

So, are the amyloid-busting drugs worth getting excited about or are they just a mirage?

Certainly, some kind of breakthrough is sorely needed against Alzheimer's, the most common form of dementia. Due to rising life expectancies, Alzheimer's is on the increase and current drugs only slightly alleviate the symptoms of memory loss and confusion, without doing anything to slow the condition's progress.

A build-up of amyloid in the brain has been suspected as the root cause of Alzheimer's since the 1980s. Clumps of this protein, known as plaques, can be seen in the brains of those affected and the few genes that have a strong causative role in early-onset Alzheimer's raise amyloid levels.

But the quest to develop amyloid-destroying drugs hasn't gone smoothly. After dozens of compounds designed to lower amyloid one way or another failed in trials, doubts were raised about whether the amyloid hypothesis of Alzheimer's was even correct.

More recently, the amyloid story turned a corner. In 2021, a drug called aducanumab – which consists of antibodies that bind to amyloid – was approved by the US Food and Drug Administration (FDA) on the basis that it reduces amyloid plaques, despite having no effect on memory.



REUTERS/GONZALO FUENTES

New drugs may aid those with Alzheimer's and their families

In January 2023, the FDA approved a second amyloid antibody called lecanemab, which both reduces plaques and, crucially, slows memory decline. Then, this month, results showing a similar slowing of memory loss were released for a third antibody called donanemab.

Each of these events was welcomed by patient support groups, with some media reports describing the treatments as a "momentous breakthrough".

"In the space of six months, we have had two disease-modifying treatments that not only show the removal of amyloid, but also show patient benefit," says Richard Oakley at the UK's Alzheimer's Society. "We are in a new era."

But look a little closer and the picture may not be so rosy. Firstly, it is doubtful if any of the drugs have an effect on memory that is big enough to be noticeable by people with Alzheimer's or their families. For instance, in the 18-month trial of lecanemab, those receiving the drug worsened by 1.2 points on an 18-point scale used to rate dementia symptoms. Those who got a placebo worsened by 1.7 points – just half a point more. Doctors have previously estimated that it would take a minimum of a 1-point difference on this scale for a treatment to make a meaningful improvement to people's lives. A 0.5-point difference is really undetectable, says Lon Schneider at the University of Southern California, Los Angeles.

> "In 10 years' time, I'll be very surprised if lots of people with Alzheimer's are on these drugs"

While the antibodies have been lauded as the first "disease modifying" treatments, the size of their effects on this 18-point scale is about half that seen with the available drugs that just mitigate symptoms, says Rob Howard at University College London.

Worrying side effects

A spokesperson for lecanemab's manufacturer, Eisai, says: "We are confident that the results demonstrated by the study are clinically meaningful. For patients in the early Alzheimer's stage, a change of score [of half a point] in the memory domain means progressing from benign forgetfulness to moderate memory loss." Donanemab's manufacturer, Lilly, says the paper that suggests a 1-point change on the symptom scale is needed was referencing differences between individuals, not the averaged effects on groups of people. "Application of such differences to a treatment group versus an individual patient level may be misleading."

Nevertheless, another concern is side effects. The antibodies seem to bind to amyloid within the walls of blood vessels in the brain. This can lead to leakage of fluid from the blood vessels, resulting in brain swelling, bleeding and, in a few cases, deaths. "Having a kind of immune reaction to something in the wall of your blood vessel isn't great for that blood vessel's integrity," says Howard.

Yet this alone doesn't have to be a dealbreaker for the drugs' use, says Dennis Selkoe at Harvard Medical School. Other drugs have risky side effects, such as those for treating cancer or multiple

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Genetic minefield

If new Alzheimer's drugs start being used (see main story), there will probably be an uptake of a particular genetic test, which can have disturbing repercussions.

The test involves the gene *ApoE*, a variant of which puts people at higher risk of Alzheimer's: people with one copy have about double the relative risk as those without, while two copies raises the risk approximately 10-fold.

Until now, there was little reason to take the test because there are no preventative treatments for Alzheimer's and it is debatable whether people would want to know that they carry this variant, which also raises the risk of brain swelling. But one drug manufacturer, Eisai, recommends that those with Alzheimer's take the test to learn if they have the variant and could therefore be at higher risk of brain swelling before they begin the treatments, which can cause this problem as a side effect.

If they learn they have the variant, this would have consequences for their relatives: if a parent has two copies of the variant, their child must have one copy and may have two.

Finding this out could affect their prospects of getting health or life insurance in some countries. US rules are unclear on whether knowledge of a relative's genetic test results has to be disclosed to insurers, says Madhav Thambisetty at the National Institutes of Health in Baltimore, Maryland. "It's an ethical and legal grey area."

sclerosis, but we inform people about these adverse events and let them decide. People can also take genetic tests to see if they are at a higher risk of both Alzheimer's and these side effects, although that can cause its own issues (see "Genetic minefield", left).

Setting aside concerns over safety and efficacy, the treatments also bring practical difficulties. The antibodies have to be given by regular infusions and recipients need regular brain scans to check for brain swelling or bleeding.

Even in the US, most health insurers won't cover the cost of the two treatments approved so far. For lecanemab, the leading contender in this field, this will probably be $26,500 a year because it hasn't yet gained the standard form of FDA approval, only the more tentative "accelerated approval".

The final FDA decision on lecanemab is due in July. Until then, Medicaid and Medicare – the country's two biggest public health insurers – will only fund its use as part of research. One public insurer, the Veterans Health Administration, has agreed to fund lecanemab for general use, but most private insurers follow the lead of Medicaid and Medicare.

1.2

The worsening of dementia symptoms on an 18-point scale in people taking a new drug

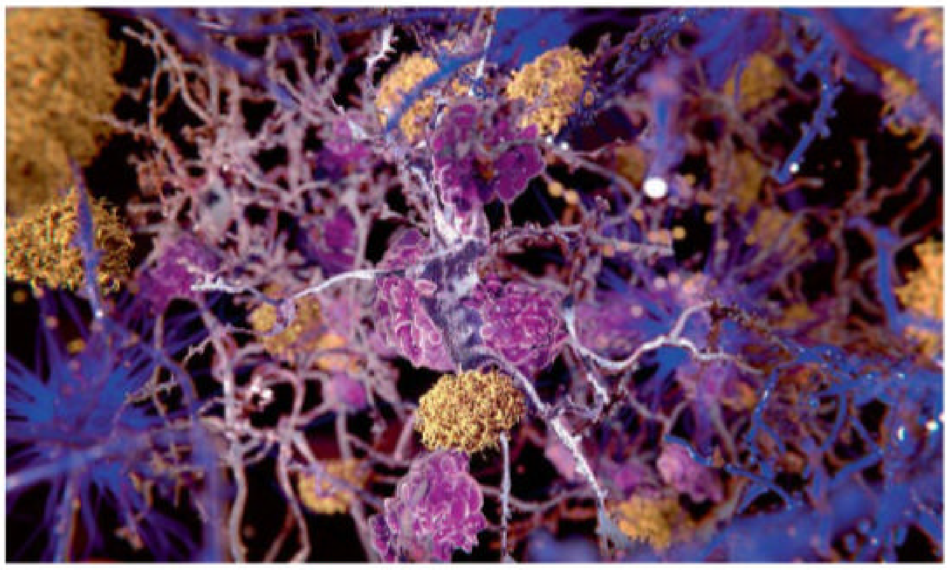
1.7

The worsening of dementia symptoms in people taking a placebo

1.0

The point difference between a drug and a placebo required to be clinically meaningful

An illustration of amyloid plaques among neurons, a sign of Alzheimer's



JUAN GAERTNER/SCIENCE PHOTO LIBRARY

In the UK, where new medical treatments can only be introduced if they are judged to provide value for money by bodies such as the National Institute for Health and Care Excellence (NICE), prospects for these drugs' use seem more remote. It doesn't help that they wouldn't slot neatly into current healthcare for people with dementia. The drugs are designed to be given early in the condition's onset and, at the moment, people with dementia symptoms may not get a formal diagnosis until relatively late in their illness, if at all. Care is also generally provided by mental health services that lack brain-scanning machines or the ability to give antibody infusions.

On the other hand, if the antibodies were to trigger an overhaul of dementia care, meaning more people get an early diagnosis, that could bring its own benefits, says Oakley. But given the treatments' barely detectable effects on memory, such arguments seem unlikely to sway NICE, says Howard.

All these issues are leaving people affected by Alzheimer's and their families in a kind of limbo. There are news reports of breakthrough treatments, yet, in practice, the drugs aren't available. People may read claims that the drugs are disease modifying, but, in reality, they will probably have no noticeable effects.

Howard says the amyloid antibodies should be seen as somewhat of an advance for Alzheimer's science, by confirming that the protein plays a role in the condition. "This is positive news, but it is a tiny, incremental step that probably isn't going to have a big impact in the clinic," he says. "In 10 years' time, I'll be very surprised if lots of patients are on these drugs." ■

History

Kissing has been part of romantic encounters for at least 4500 years

Michael Le Page

SEXUAL kissing was practised in ancient Egypt and Mesopotamia at least 4500 years ago, according to a review of ancient texts.

There is much debate about when humans began kissing in a romantic way. Many sources say the earliest evidence is in Sanskrit texts written in what is now India around 3500 years ago. Some researchers have suggested that such kissing spread around the world from there and Alexander the Great's conquests are often said to have played a part in this.

The idea that sexual kissing had a point of origin has, in turn, been linked to the spread of some diseases. For instance, a 2022 paper said that the herpes simplex virus 1, which causes cold sores, may have become more common because of "the advent of sexual-romantic kissing".

But evidence from Egypt and Mesopotamia suggests kissing arose in many places, says Troels Pank Arbøll at the University of Copenhagen in Denmark. "It shows it was known in a much wider area in the ancient world than the people formulating these theories have considered," he says.

This has been known for decades by people who can read the cuneiform writing system used by several ancient civilisations, but not more widely in science because the details aren't cited anywhere, says Arbøll.

So, Arbøll and his wife, biologist Sophie Lund Rasmussen at the University of Oxford, decided to gather the overlooked evidence.

Egyptian King Senusret I in an embrace with Ptah, the creator-god


AKIMOV KONSTANTIN/SHUTTERSTOCK

While kissing is rarely referred to in Mesopotamian texts, those mentions show it was considered an ordinary part of romantic intimacy, says Arbøll. For instance, one text from about 3800 years ago describes how a married woman came close to being unfaithful after a kiss. Another text from the same time describes an unmarried woman vowing to avoid kissing and having sex with a man (*Science*, doi.org/kbjc).

Considering the geographical distribution, sexual kissing must have had multiple origins, says Arbøll. "It's not something that originated in a single place."

He and Rasmussen also point out that there is tentative evidence that modern humans and Neanderthals kissed, or at least exchanged saliva in some way. What is more, bonobos also engage in mouth-to-mouth sexual kissing. So it is possible people have been kissing sexually for much longer than written history suggests. "I think it's very likely that it goes far back," says Arbøll.

However, a 2015 study by William Jankowiak at the University of Nevada, Las Vegas, and his colleagues found no evidence of sexual kissing in hunter-gatherer societies.

"My hunch is that kissing arose or was discovered amongst the elite in complex societies," says Jankowiak. The elite were able to pursue pleasure and turn sex into an erotic encounter, he says.

Jankowiak did find that sexual kissing is more common in cold climes. This may be because while clothing covers most of the body to keep people warm, the face is still available to touch, he says.

Ecology

Wolves are scaring smaller predators into human conflict

FEAR of large predators is pushing bobcats and coyotes into closer contact with humans, with fatal consequences.

Overhunting drove US wolf and cougar populations to a sliver of their former abundance in the 1900s. Since then, protections under the US Endangered Species Act have helped the species recover. Because wolves and cougars eat bobcats and coyotes, researchers anticipated that the return of the top predators would control the number of smaller animals.

To investigate, Laura Prugh at the University of Washington in Seattle and her colleagues tracked the movements of 22 wolves (*Canis lupus*), 60 cougars (*Puma concolor*), 35 coyotes (*Canis latrans*) and 37 bobcats (*Lynx rufus*) using GPS collars between 2017 and 2022. They followed the animals across two forested regions of Washington state punctuated by roads, ranches, homes and small towns.

When wolves and cougars moved into an area, bobcats and coyotes spent more time near the developed and human-populated areas that wolves and cougars typically avoid. This move often had fatal consequences: around half of the coyotes and most of the bobcats that died during the five-year study period were killed by people.

"A few coyotes and bobcats were shot while trying to raid chicken coops," says Prugh, and others were shot on sight or snagged in traps.

"A few coyotes and bobcats were shot while trying to raid chicken coops"

Humans killed between three and four times as many small carnivores as the wolves and cougars did (*Science*, doi.org/kbjd).

Earlier studies on small carnivores suggested the animals had a strong fear of people, so "we were a little surprised that they shifted more towards humans in the presence of large carnivores", says Prugh.

The discovery suggests the phenomenon known as the "human shield effect", in which some animals seek refuge near people, can be lethally self-defeating.

Corryn Wetzel

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Technology

Stretchy e-skin responds to touch like the real thing

Karmela Padavic-Callaghan

A PATCH of artificial skin can convert inputs from pressure and heat sensors into brain signals. It could be used to improve prostheses for people who have skin damage.

Weichen Wang at Stanford University in California and his colleagues have created e-skin out of an electronic circuit and pressure and temperature sensors, all crafted from a thin, rubbery material.

The e-skin works by imitating biological skin, where nerves detect pressure or warmth and then send sequences of electrical signals, or "pulse trains", to the brain.

When the researchers heated the patch or applied pressure, the e-skin's sensors sent signals into the circuit, which converted them into pulse trains.

To do all this, the e-skin needed only about 1/60th of the voltage used by previous artificial skin devices. This should mean it won't heat up as much, making it more comfortable for longer use, says Wang.

When we feel things, it can trigger quick muscle movements, so the researchers tested to see if the e-skin could do something similar in a living rat. They connected it to the region of the brain that processes touch and temperature.

They then put pressure on the e-skin. The rat's brain reacted by firing more signals between neurons in the region that controls movement. When the researchers routed those signals into the rat's leg through an artificial synapse, it kicked (*Science*, doi.org/gr8rk6).

"This is not a small thing – it's quite challenging work to get the electronics to work well enough for this," says Ravinder Dahiya at Northeastern University in Massachusetts.

However, he says that the e-skin may need even more sophisticated circuity to be used in place of large areas of skin. ▮

Archaeology

Stone Age markings are oldest known architectural plans

Christa Lesté-Lasserre

PEOPLE created precise diagrams of vast, stone-walled hunting traps 9000 years ago, representing the oldest known architectural plans to scale in human history.

The plans were etched into stone tablets that have been discovered close to the elaborate traps, known as desert kites, which span such wide distances that their shapes are only recognisable from the air.

The findings confirm that Neolithic humans had an "underestimated mental mastery" of landscapes and space, well before they became literate, says Rémy Crassard at the French National Centre for Scientific Research (CNRS).

"There's no doubt that these *Homo sapiens* had the same degree of intelligence that we do, but this is the first time we actually have concrete proof of their spatial perception," he says.

Kites in Saudi Arabia and Jordan have funnelling lines up to 5 kilometres long and up to 10 pointed branches leading to pits as much as 4 metres deep.

"I can easily imagine that these engravings would have formed a vital element of planning"

Named by pilots who first discovered them from the air in the 1920s and thought they looked like toy kites, the structures probably lured gazelles or other animals into small areas where they would get cornered or fall, says Wael Abu-Azizeh at the French Institute for the Near East.

Despite the complexity of these Stone Age structures, the rare artistic representations of them found so far have been rough, abstract sketches. Researchers believed that the oldest true architectural plans that were at least intended to be to scale dated to Mesopotamian civilisations 2300 years ago.

In March 2015, Crassard, Abu-Azizeh and their colleagues came across an 80-centimetre-tall, 92-kilogram limestone tablet in an excavated campsite near a 9000-year-old kite in Jordan, with architectural plans etched into it. They found a second kite plan three months later, this time etched into a 3.8-metre-tall sandstone boulder that had fallen from a cliff near a pair of 7500-year-old kites in Saudi Arabia.

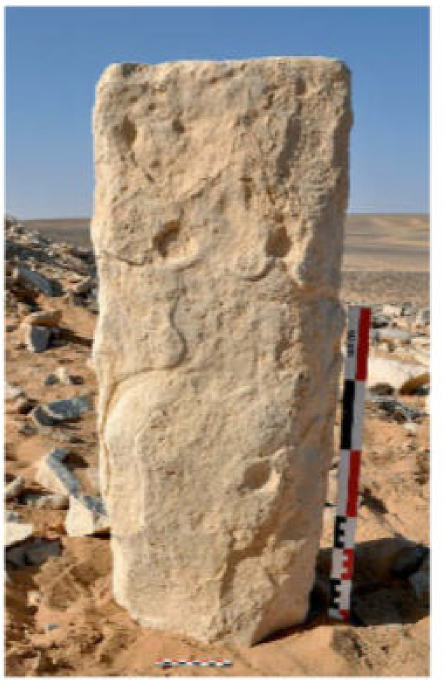
"Finding one was already exceptional, but finding two was even more exceptional," says Crassard. "We were yelling and dancing around!"

Recognising similarities with the kites nearby, the researchers used computer modelling to compare the engraved images with satellite images of 69 kites. They found that the plans etched into stone were "surprisingly realistic and accurate" depictions of actual kites within 1 to 2 kilometres, says Crassard. The two plans had been created at scales of 1:175 and 1:425 and even included three-dimensional pitting to represent the kites' pit traps (*PLoS One*, doi.org/gr8pf8).

The plans might have helped build the huge structures, and could also have helped hunters understand how to use them, says Abu-Azizeh.

Like football coaches drawing tactics on a white board, members of the Neolithic community may have used the scale images to communicate group hunting strategies, says Sam Smith at Oxford Brookes University, UK. "I can easily imagine that these engravings would have formed a vital element of planning."

The fact that they were engraved in "such a durable medium" suggests they may have been intended to last for future generations, he adds. "New members of the community, or hunting party, would not have any real way to comprehend the kites without depictions such as these," says Smith. ▮





L: SEBAP & CRASSARD ET AL. 2023 PLOS ONE; R: O. BARGE, CNRS

This rock (left) found in Jordan features a to-scale plan of a huge desert trap similar to the unexcavated one pictured above, showing the winding route used by hunters to drive animals towards pits

Evolution

Comb jellies, not sponges, might be the oldest animal group

James Dinneen

WERE sponges or comb jellies the first to split from the animal family tree? A new approach at settling this question, which is critical to understanding the evolution of animals, points to comb jellies – but not all researchers are convinced.

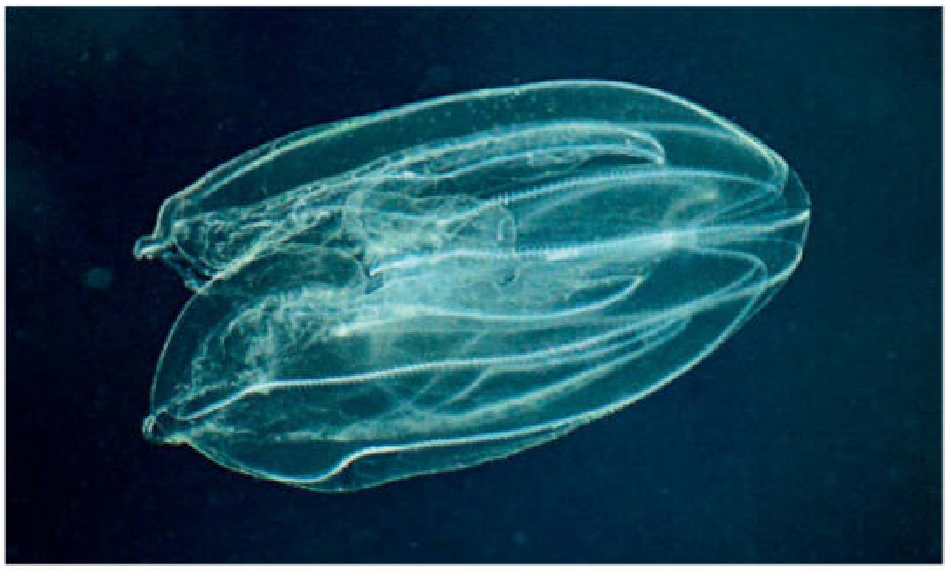
All animals alive today are thought to be descended from a common ancestor that lived more than 600 million years ago. Until fairly recently, researchers thought that sponges were the first group to split from this common ancestor and begin evolving separately. The next group to diverge from the animal family tree was then comb jellies.

But this idea was challenged by a 2008 study based on sequenced genomes that found comb jellies appeared to have split off first. Since then, papers arguing both sides have flown back and forth "like a ping-pong match", says Darrin Schultz at the University of Vienna in Austria. "People feel like they've been banging their heads against the wall."

Now, Schultz and his colleagues have pursued a new line of evidence. Where previous studies compared changes in the DNA sequences of comb jellies, sponges and other animals, his team looked at larger patterns in the order of genes on chromosomes.

The idea is that these patterns – known as synteny – are more stable, says Schultz. While individual genes can be reshuffled by evolution, the reordering of linked groups of genes caused by mixing and fusing chromosomes is a rare and irreversible event.

The American comb jelly (*Mnemiopsis leidyi*) has a long heritage



SHUTTERSTOCK/SASKIAACHT

Schultz's team compared shared patterns of synteny between two species of comb jellies, two species of sponges and two species from other animal groups. To determine patterns before divergence, the researchers looked at 31 groups of genes shared between comb jellies and at least one of three single-celled ancestors of all animals.

In seven of these groups of genes, the comb jellies had patterns of synteny that were present in at least one single-celled ancestor, but missing in sponges and the other animal groups (*Nature*, doi.org/kbg5). This suggests the comb jellies split away before the reordering events that gave the other animals distinct shared patterns, says Schultz. The possibility that the pattern occurred by chance is extremely unlikely, he says.

"I'd say this is the strongest evidence to date in favour of the jellies-first hypothesis," says Aoife McLysaght at Trinity College Dublin in Ireland, whose own work has come down in favour of sponges. But she would like to see more work to understand how to reconcile the finding with the DNA sequence-based approaches that have found sponges split first.

The results could upend our understanding of the evolution of neurons and other systems, says Kenneth Halanych at the University of North Carolina Wilmington. For instance, sponges don't have neurons, but comb jellies do. If comb jellies split first, it could mean neurons evolved independently in comb jellies and other animals groups. ■

Exercise

Running fast puts more strain on shins than going uphill

RUNNERS may face a greater risk of developing fractures in their shin bones when they run quickly than if they run uphill or downhill.

The repetitive pounding motion of running can lead to painful injuries known as "shin splints" and even fractures. These fractures often happen when people train more intensely, but it isn't well understood which training routines are most likely to cause the injuries.

Now, Michael Baggaley at the University of Calgary in Canada and his colleagues have recorded 17 people on a treadmill to investigate.

Each person completed several runs, at three different speeds and five different inclinations, while the researchers measured the force of their feet hitting the treadmill and used motion-capture technology to record the movements of their legs.

To determine when shin bones were at greatest risk of fracture, the researchers combined the force, acceleration and speed data from the runs with a mathematical model for how muscles pull on leg bones.

The researchers also adjusted the model for characteristics of each runner, including height and weight (arXiv, doi.org/j99b). Speed had the most impact on shins. "We didn't see a difference in the strains, which we believe are associated with stress fracture development, when you run uphill or downhill. But it was obvious that when volunteers ran faster, these strains increased quite a bit," says Baggaley.

> "It was obvious that when volunteers ran faster, the strain on their shins increased quite a bit"

He says changes in inclination may have a less pronounced effect because human legs evolved to adjust to changing terrain rather than for increased pace.

The idea that how hard your foot hits the ground is the determiner of how much force your leg bones experience has been a big misconception, says Karl Zelik at Vanderbilt University in Tennessee.

Baggaley says that although other factors may contribute to shin fractures, such as malnutrition or past injury, slower is better for anyone worried about it. ■

Karmela Padavic-Callaghan

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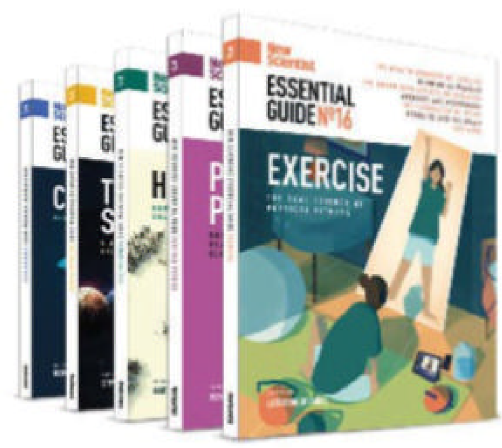
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Physiology

Racing drivers have synchronised blinks

DRIVERS blink at around the same points as they roar around a track.

Ryota Nishizono at NTT Communication Science Laboratories in Japan and his colleagues got three professional male drivers to do 304 practice laps of three circuits in Japan: Fuji, Suzuka and Sugo. A binocular eye tracker mounted on their helmets recorded their blinking.

We generally blink 12 times per minute, but some people blink less when they concentrate. Although the blinking frequency of the drivers differed, they blinked at around the same points on each circuit (*iScience*, doi.org/kbjj).

As their steering patterns were similar, the blinking could reflect synchronised mental states as they concentrate on driving, says Nishizono. **Soumya Sagar**



ANJAR PRIMASETRA

Chemistry

Octopus-inspired ink can change colour

AN INK that changes colour when exposed to light, like an octopus does to match its surroundings, could one day be used for automatic camouflage.

Jinyao Tang at the University of Hong Kong and his colleagues made the ink from particles of titanium dioxide, each with different dyes and varying light responses, arranged in a solution.

When light is shone on material containing the ink, a chemical gradient causes some ink particles to rise to the surface and others to fall, so the material matches the colour of the light hitting it.

The colours stayed stable for about half an hour before the ink remixed (*Nature*, doi.org/gr8qzk).

The ink could one day be useful for automatic camouflage, such as matching the green of a forest or yellow of a desert, says Tang. **Alex Wilkins**

Materials

A house made from recycled diapers mixed into concrete

CONCRETE made from recycled diapers, instead of sand, is strong enough for building houses.

Sand is crucial for many building materials, from concrete to plaster to glass, but demand is set to rocket in coming decades and it is unclear how much sand is left to extract.

Siswanti Zuraida at the University of Kitakyushu in Japan saw an opportunity to reuse diapers. "Every day, babies are born and how many diapers do we produce?"

To make a prototype, Zuraida and her colleagues used diapers from her own children. The team washed, sterilised and dried them, before shredding and mixing them with different amounts of materials, such as gravel or sand. This served as the aggregate the team mixed with Portland cement and water to create concrete.

While the modified concrete had slightly less compressive strength than pure concrete, samples that were 8 per cent diapers could be used for structural features like supporting beams and columns, according to Indonesian building regulations, for example. While not as strong, samples that were close to 40 per cent diapers could be used for non-load bearing features like walls and floors, according to the same regulations.

To test this, the team built the walls and floors of a 36-square-metre house using the 40 per cent diaper concrete, with load-bearing features made from regular concrete (*Scientific Reports*, doi.org/kbhz).

The construction required about 200 diapers, says Zuraida. A baby can use as many as five a day, she says, so there is no shortage. The bottleneck on scaling up the method will be collecting used diapers from households, she says. **AW**

Really brief



GRIGOREV MIKHAIL/SHUTTERSTOCK

Zebrafish make sunscreen for eggs

Mother zebrafish produce sunscreen to protect their eggs and transparent embryos from UV light. The fish stock up the eggs they lay with a compound called gadusol that acts as the sunscreen. Most eggs or larvae that don't have this protection don't develop or die if exposed to UV light (bioRxiv, doi.org/gr8p5h).

Microbombs blast away tooth bacteria

Bacteria that cause tooth decay could be blown away by microscopic "bombs" detonated with an ultrasonic toothbrush. The tiny capsules burst open when hit with ultrasound waves, releasing chemicals that destroy the films of bacteria (*Advanced Functional Materials*, doi.org/kbjb).

Gibbons plan to get best breakfast spot

Skywalker gibbons (*Hoolock tianxing*) get up early when they want fruit for breakfast, leaving up to an hour earlier than when they want leaves. Such a capacity for planning has rarely been documented in wild animals (*Proceedings of the Royal Society B: Biological Sciences*, doi.org/kbh7).

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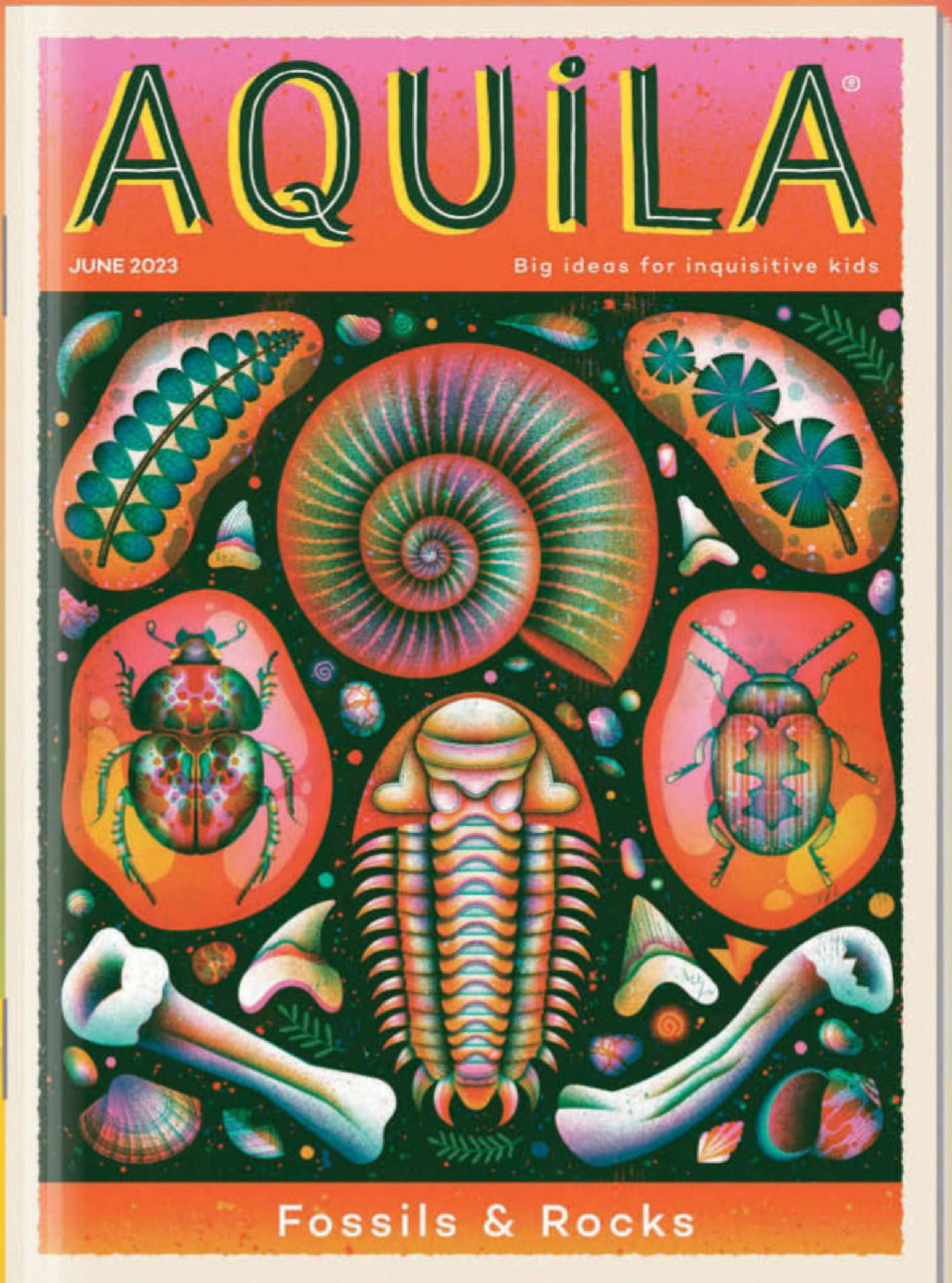
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Comment

Messaging the stars

If there are intelligent aliens out there, should we try to communicate with them? And who should speak for Earth, asks **Chris Impey**

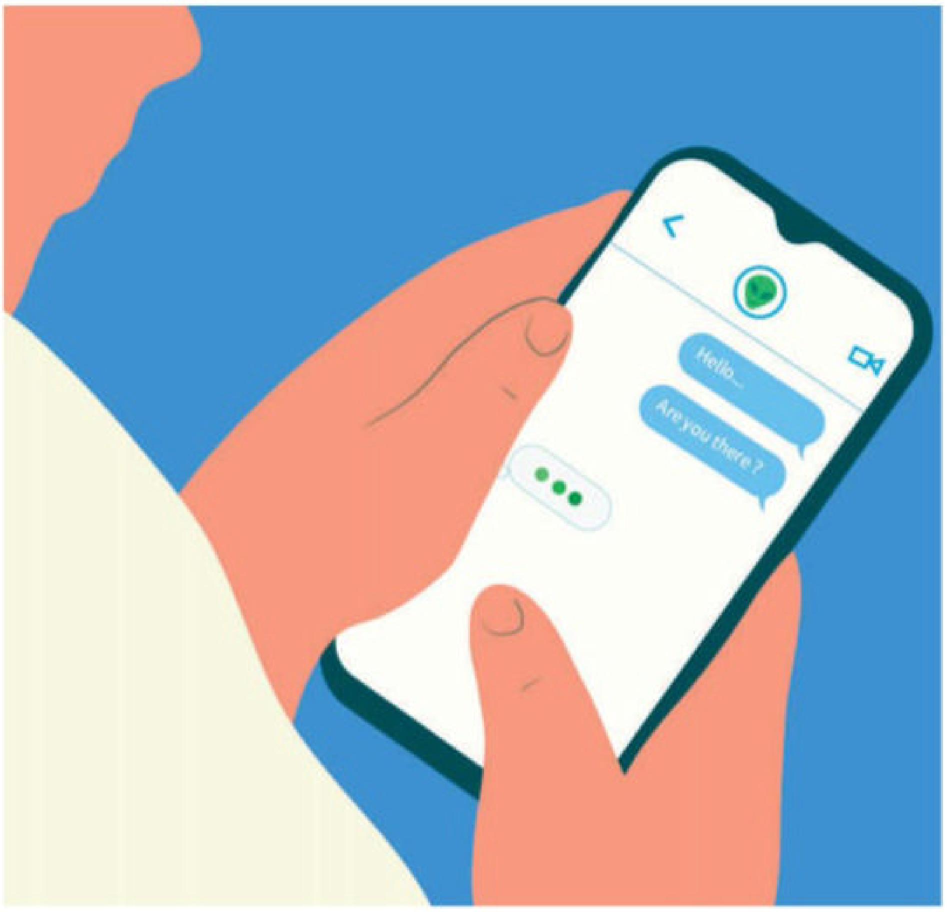
FOR 75 years, astronomers have been searching for extraterrestrial intelligence. SETI involves listening for radio or optical signals sent by intelligent civilisations. No artificial signals have yet been detected. The failure of SETI is called "The Great Silence", but despite this, many scientists are confident that intelligent aliens exist. There are thought to be at least 10 billion habitable worlds in our galaxy, and billions of years have passed in which any life on them could have developed intelligence and technology.

METI, or messaging extraterrestrial intelligence, has been less common. It involves talking rather than listening. To some, it is a controversial activity.

The first attempts at communication were quixotic "messages in a bottle". In 1972, NASA launched the Pioneer 10 spacecraft towards Jupiter, which carried a plaque with a line drawing of a man and a woman as well as symbols to show where the craft originated. In 1977, NASA followed this up with a golden record attached to the Voyager 1 craft. The 12-inch record held sounds and images chosen to convey the diversity of life on Earth.

Both spacecraft have left the solar system. At their current speeds, it will be tens of thousands of years before they reach another star system. In the immensity of space, the odds that they will be found are minuscule.

In 1974, a radio message was beamed from the Arecibo Observatory. A series of on-off radio pulses, designed to convey simple information about humanity, was sent towards the globular cluster M13. Since M13 is 25,000 light years away, we shouldn't hold our breath for a reply.



MICHELLE D'URBANO

Now, an international team of astronomers plans to use the world's largest radio telescope, FAST, located in China, to beam a message towards millions of stars that are 10,000 to 20,000 light years away. The new message is an amalgam of previous ones. It contains 25,000 bytes of information, 100 times more than the Arecibo message, but 100 times less than a photo from a smartphone.

NASA signals to its remote spacecraft, meanwhile, have reached four nearby stars. A reply from aliens living in the vicinity could reach us by 2029.

But perhaps we have already betrayed our existence to aliens. Radio and television signals have been leaking into space for nearly a century, in an expanding bubble of communications that spans millions of stars – in theory, at least. When I did the maths, it turned out the signal from an early episode of *Doctor Who* faded below the hum of radiation from the big bang soon after it left the solar system.

The ethical question raised by METI is: should we be sending a message at all? Scientists are divided. Before he died, Stephen Hawking was outspoken about the danger of communicating with aliens. If they have superior technology and are malign, they might destroy us. Others see no problem, given that the signals take millennia to reach their destination. No international rules govern METI, so the experiments will continue.

Another question is: who speaks for Earth? In the absence of an international consultation with the public, decisions about what to send and where to send it are in the hands of a small group of scientists. That is probably unwise.

My own take is that the risk is abstract when the message will take millennia to be received. We have more proximate and existential threats than evil alien empires. My guess is that extraterrestrial intelligence and tech are so advanced that they are inscrutable. We share 99 per cent of our DNA with chimps and can't communicate with them. So, what are the odds we would be able to communicate with aliens of unknown function and form?

Hear more from Chris Impey at our Instant Expert event on 17 June



Chris Impey is author of *Worlds Without End* and an astronomer at the University of Arizona

Field notes from space-time

Best not to ask

It feels like it should be easy to define space-time, but the concept is so outside the realm of everyday life it can seem beyond comprehension, says **Chanda Prescod-Weinstein**



Chanda Prescod-Weinstein is an assistant professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her research in theoretical physics focuses on cosmology, neutron stars and particles beyond the standard model

Chanda's week

What I'm reading
I am enjoying The Five Sorrowful Mysteries of Andy Africa*, a novel by Stephen Buoro.*

What I'm watching
A lot of adaptations of Alice's Adventures in Wonderland*. The 1933 film is my favourite.*

What I'm working on
I have a new idea about dark matter in neutron stars that I want to test out, mathematically.

This column appears monthly. Up next week: Graham Lawton

THERE are two questions that I somewhat dread when communicating science to the public. And, unfortunately, they are rather common, because they are interesting to everyone, myself included. The first is: "What was there before the beginning of the universe?" The second: "What is space-time?"

You might think that I would actually relish the opportunity to answer such queries because they go to the heart of what theoretical cosmologists like me do. It is literally in the job description, which I often tell people is to try to understand the origin and evolution of space-time and everything inside of it.

Despite this clear and rather monumental mandate, I actually try to avoid answering the question of how the universe began or what was there before, because it isn't clear that this is an enquiry physics can answer. Let me refine what I mean a bit. First, consider a definition of "the universe". Technically speaking, I mean space-time, which is the place where everything we know exists. It is the only place we know; the only cosmic home we can ever have, as far as we are aware.

We have already run into my other problem: trying to define space-time for audiences. It feels like it should be simple. We are used to thinking of a place as existing in terms of "space": a physical location independent of time, the basis of Isaac Newton's view of the cosmos. But Albert Einstein's relativity showed us that, in order to properly account for the finite speed of light, we could no longer think in these terms. Instead, space and time must be one phenomenon, where the different components mix. This feels like a rather dramatic conclusion to come to, given that the only new ingredient that we added to classical, Newtonian physics was a finite speed of light.

But this is a lesson in how one change to the physical laws can radically transform our mechanical understanding of the cosmos. The finite speed of light suggests that no matter what speed someone is moving, they have to measure the same speed of light as someone else moving at a different speed. When we sit down to work out the equations that describe this, the only way to make each person measure the same speed of light is to conclude that time flows differently for people moving at different speeds relative to one another. This outcome implies that space and time can't be separated from one another.

> "Our intuition is a helpful, but imperfect, guide, and the universe is bigger than our experiences"

Combining space and time into one inseparable entity is so outside the realm of everyday life that for most people, if not all, this will feel unintuitive and therefore wrong. But one of the lessons we must learn as empirical thinkers is that our intuition is a helpful, but imperfect, guide, and the universe is bigger than our experiences. And by the universe, I now specifically mean space-time, which is 100 quadrillion times bigger than Earth – almost unfathomably large.

You might say that I literally just explained that space-time and space aren't the same thing, yet here I am comparing space-time to Earth. You see why I dread this conversation a bit? It is partly because the questions I get in response are smart. And this is a good point, that it can feel a bit like I'm comparing apples and oranges. But to be clear, I haven't suggested that we can no longer measure distances. The number I quoted above is a ratio based on the size of the observable universe: it is what we can see.

And here is what is interesting about the size of the observable universe: it stretches 46.5 billion light years in all directions. So you would imagine this implies that some of the light we might see could have been travelling to us at the speed of light for 46.5 billion years and that 46.5 billion years is the age of the universe. In fact, the universe is only about 13.8 billion years old.

We are tempted to arrive at the first, wrong answer when we ignore the fact that space-time is expanding, carrying light along with it and stretching it out. The expansion and changing size of space-time is a dynamical effect that is produced through the mixing of space and time together. It is in this sense that I compare the size of Earth and the universe itself.

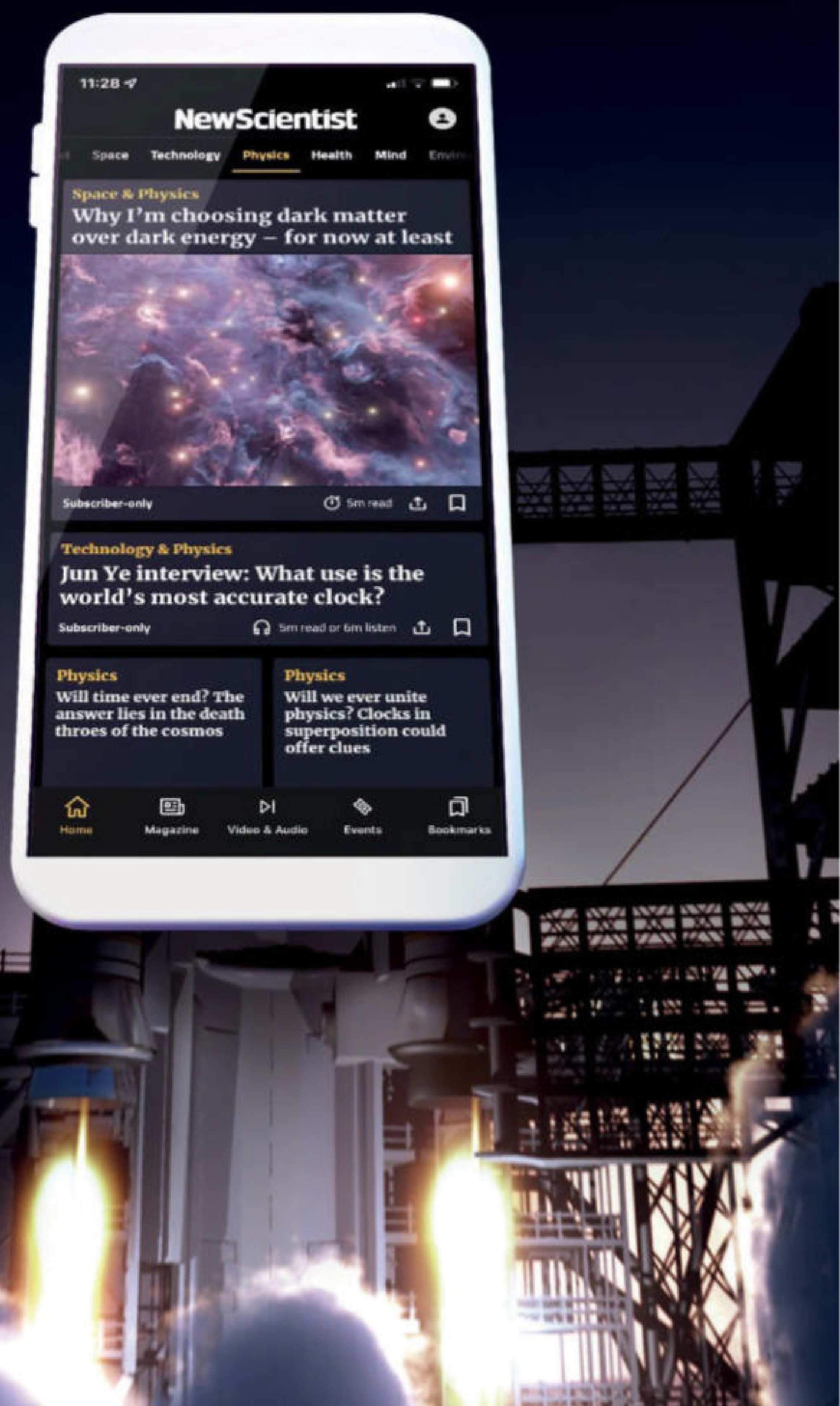
But now we are talking about an age, that raises the obvious question of the universe's birth. Look, I'm happy to discuss what happened when the universe was 10^{-36} seconds old. This was the era of inflation, when space-time expanded exponentially. Inflation is so far the best explanation we have for why, at large scales, our universe roughly looks the same in every direction, from every location. So it isn't like I am unwilling to discuss the almost beginning of space-time. But the answer is that our equations become completely dysfunctional at time zero. We have no idea what came before.

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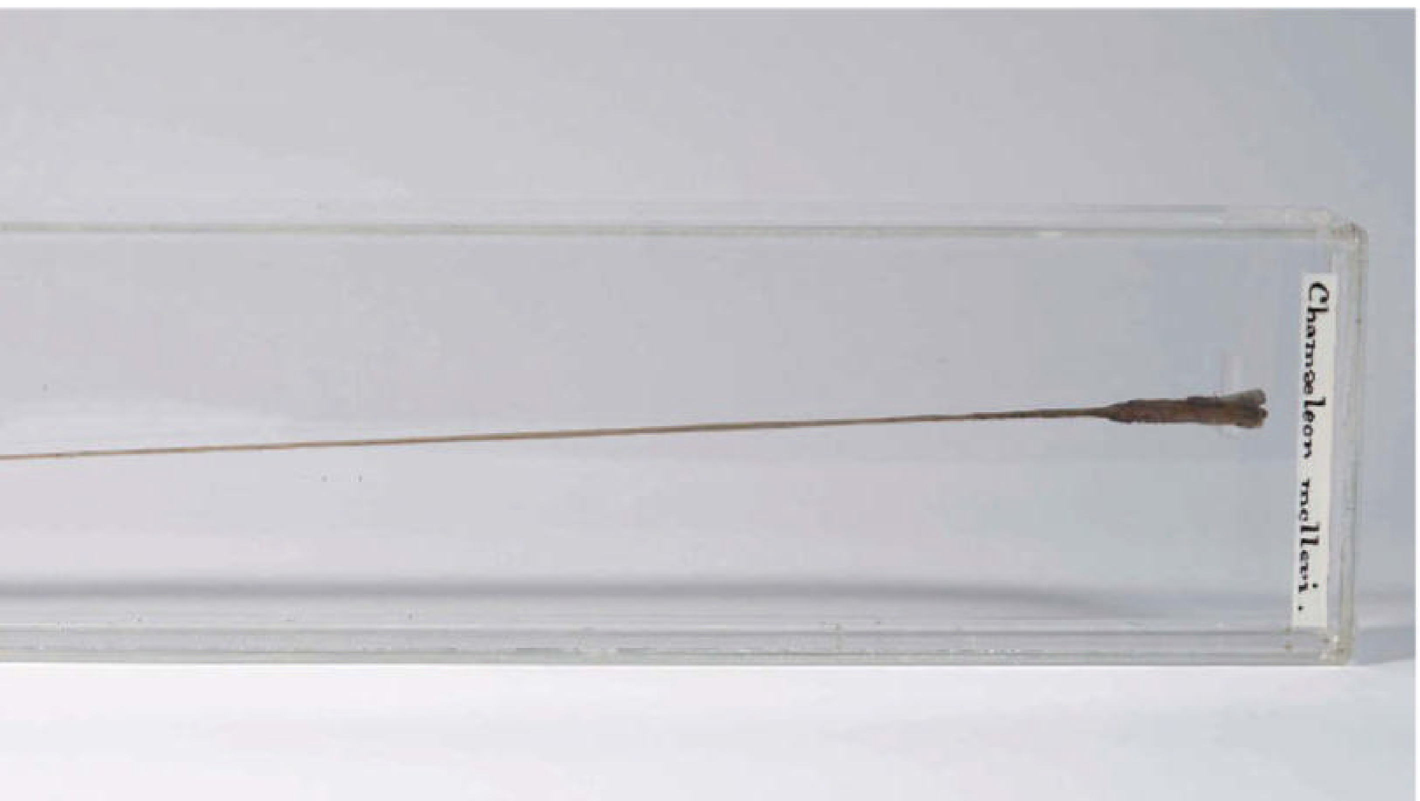



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New Scientist video
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Still life

Royal College of Surgeons of England

OFFERING a unique peek into the science of a bygone time, these anatomical specimens from the Hunterian Museum in London tell a story of medical discovery and curiosity through the ages.

Named after the 18th-century surgeon John Hunter, the museum has reopened to the public after being closed for redevelopment for the past five years. The displays reveal Hunter's flair for anatomy and dissection, and his passion as an exotic animal collector.

Hunter's surgical skills and knowledge of the human body were gleaned from his extensive studies of cadavers, although he had some murky methods of acquisition. He was known to have partnered with "body snatchers" to acquire corpses freshly dug from graves, and also obtained the body of 2.3-metre "Irish Giant" Charles Byrne after his death, ignoring Byrne's wishes to be buried at sea. Byrne's skeleton had long been on display at the museum, but because of the sensitivities involved, it has been removed from the latest display.

Among Hunter's preparations are a human femur, or thigh bone (top, far left), and, to its right, a preserved head of a king vulture. The moment a baby crocodile emerged from its egg (far right) was also immortalised. These are part of a staggering collection of more than 13,000 specimens of some 500 species accrued by Hunter, around 2000 of which are being exhibited at the museum.

Also shown are microscope slides of a butterfly wing and lizard (far left) prepared by 19th-century histologist and microscopist John Quekett, and the long tongue of a chameleon (bottom right). ■

Gege Li

Editor's pick

How to think about... scientific thinking

13 May, p 36

From Kate Hopkinson, London, UK

In the introduction to your piece on how to consider various tricky issues in science, such as consciousness, you mention that new evidence and fresh ways of thinking both add to the evolution of our understanding.

Some of our frustration with tackling the major challenges that confront science might be due to a failure to refresh the conceptual architectures we use in our thinking. One example of the difference this can make is that using a both/and logic opens up a different and larger space of possibilities than using an either/or logic, whatever the subject.

Another relevant example might be an approach that includes context, versus one that doesn't, to make sense of any complex issue. Having only a keyhole view of the problem leads to significant drawbacks, as we are seeing with artificial intelligence.

The time may be right to focus on this hidden substructure to thinking. This could create a fruitful new horizon, enabling us to break out of constraints we are unaware of.

Lab-grown meat can be environmentally sound

13 May, p 11

From Liz Specht, The Good Food Institute, Washington DC, US

Scientists developing cultivated meat agree that R&D-scale methods won't work for large-scale production. The non-peer-reviewed environmental impact study you reported on assumed commercial production of cultivated meat would rely on pharmaceutical-grade media to feed the cells – which food manufacturers won't need to use.

Its findings deviate from other published research and don't reflect current or anticipated practices. Recent peer-reviewed data demonstrates that food-grade ingredients can support animal cell growth, and producers are actively developing the supply chain for these ingredients.

A peer-reviewed study in *The International Journal of Life Cycle Assessment*, based on input from many cultivated meat companies and media suppliers, showed that producing cultivated meat at scale using renewable energy could lower climate emissions by 92 per cent and use 90 per cent less land than conventional beef.

Just as we wouldn't assess the environmental impact of solar panels based on 1980s prototype production methods, we shouldn't assess cultivated meat's potential impact using R&D-scale processes. To deliver on cultivated meat's potential to help satisfy growing demand for meat, reduce climate impacts and create space for more sustainable farming, governments must develop sustainable, large-scale production.

Altogether now, fandom really is rather splendid

13 May, p 25

From Colin Parrish, Doncaster, South Yorkshire, UK

Michael Bond's article on fandom really struck a chord with me. A decade ago, as a reasonably intelligent man drawing his state pension, I became a fan of a television singing contestant (James Arthur). For the first time in my life, I joined a fan club.

Since then, I have become online friends with a socially diverse group of people from all over the world, some of whom I have met. Many of these people have, in Bond's words, "been transformed by their fandoms". It is easy to mock fans; we do get a bad rap. But the act of coming together in mutual support can be immensely rewarding and a powerful force for good.

From Geoff Harding, Sydney, Australia

Few fandoms can be more inclusive than devotion to a sports team. A commentator once said that few other interests allow, for example, a professor and a cleaner to talk with the same level of expertise.

On the strange lights that seem to precede quakes

6 May, p 43

From Guy Cox, Sydney, Australia

While I applaud the work of those aiming to predict earthquakes, the "mysterious" phenomena you report can perhaps be explained by well-known processes.

Triboluminescence (light generated by mechanical friction) is known. Native Americans were early users of the effect, shaking bags of quartz crystals to produce flashes of light in ceremonies. If this can produce luminescence, surely huge plates of rock sliding against each other could too?

As to animals being scared before a quake, infrasound (sound below the audible range) creates fright, even in us. It can be used in soundtracks to arouse fear. But we tend to live in places where it is drowned out. The early rumblings of an earthquake would produce such sounds and perhaps these scare horses and other animals.

What we really need is more inner goblin time

6 May, p 27

From Jakub Osika, Auckland, New Zealand

Jonathan R. Goodman's article lamenting a stay-at-home culture, or "goblin mode", that arose due to the pandemic is typical of what I call the extrovert's narrative. It reads like an almost evangelical piece on how we have all been corrupted by lockdowns and need to rediscover the social norms of old in order to save our souls.

The truth is that many people learned to value their own time more. Rather than spend personal and unpaid time with colleagues, while consuming awful coffee and supermarket biscuits, lots of people decided they had better things to do. Perhaps the problem was that, in the before times, there was too little "inner goblin" time.

Cats' hunting abilities may yet be in demand

6 May, p 34

From Sam Edge, Ringwood, Hampshire, UK

Author Jonathan B. Losos's idea to breed domestic cats to be less interested in hunting would indeed reduce the carnage on wildlife.

However, it is suggested that one of the reasons we first encouraged cats to cohabit with us was as pest controllers around granaries and the like. Those who still use them as such might be a little annoyed.

France takes a different line over ADHD drugs

6 May, p 38

From Larry Stoter, The North, Monmouthsire, UK

France, which is more resistant to the influence of pharmaceutical companies, tells a different story on attention deficit hyperactivity disorder. Perhaps because French psychiatrists don't use the DSM – a US psychiatric diagnostic manual – and adopt a more holistic approach to ADHD, including, for example diet, drug treatments are much less used. As of 2019, 7.77 per cent of children in the US take stimulant medications, while in France the figure is only 0.46 per cent.

For the record

Atorvastatin is used for high blood cholesterol (6 May, p 10).

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Paradise exploded

An unusually profound and moving sci-fi thriller artfully transcends the familiar trope of a utopia concealing a dreadful secret, finds **Neil McRobert**

Book
The Ferryman
Justin Cronin
Orion Books

IN THE canon of contemporary science fiction, reality is a shaky concept. Books and movies have probed, pummelled and pulled apart the fabric of the material world to reveal countless deceits.

Such revelations are the source of paranoid nightmares in works like *The Matrix*, *The Truman Show* or William Gibson's *Neuromancer*. Then there are the more lucid deceit-fantasies in the vein of *Total Recall*, *Inception* and *Westworld*. Elsewhere there are stories in which utopian filters obscure harrowing truths.

In this latter category you can find equal room for the gleaming pulp of *Logan's Run*, the grime of *Soylent Green* and the sheer stateliness of Kazuo Ishiguro's *Never Let Me Go*. It is no spoiler to say that a new book by Justin Cronin, creator of the bestselling fantasy horror trilogy *The Passage*, joins them in the same existential and ontological terrain.

From the moment we meet Proctor Bennett, living comfortably on the idyllic, secluded island of Prospera, it is obvious that his utopia is about to explode.

The rules of this particular paradise are convoluted, but seemingly benign. At the end of their long, enriching lives, Prosperans undergo a process of "retirement" and "reiteration". After a short break in a luxury clinic, called the Nursery, their memories are wiped and they return in adolescent bodies, ready to start life afresh.

Bennett's role as Ferryman is to facilitate this journey – something he does without concern or doubt. That is, until he is tasked with "retiring" his father. Cue a last-minute cryptic message, and Bennett is waking up to what all but the most naive reader already knows: Prospera is not what it seems.

This imbalance between the protagonist's innocence and the reader's experience could cripple a lesser novel. Doubly so, when the book is so indebted to the sci-fi classics, including the majority of those mentioned previously. Yet somehow, Cronin pulls off a trick that rivals the one performed on the Prosperans' ageing bodies, as he transmutes the well-worked themes into something not only original, but surprising and profoundly moving.

"Cronin has far more interest in the humanity of his story than in the apparatus that underpins it"

For me, though, Cronin's book has an emotional current that sets it apart from, and arguably above, the chilly speculation of many of those precursors. From the early, moving scenes, in which Bennett comforts and bids goodbye to his father before his reiteration, it is clear that Cronin has far more interest in the humanity of his story than in the apparatus that underpins it.

The Ferryman does have interesting ideas about how its future works, but aside from one key conceit – which would be too much of a spoiler to mention here – the book never dwells long on exposition.

That isn't to say Cronin can't write consummate technobabble. The central speculative technology is superbly developed and, in the way of all truly great science fiction, leaves you uncertain where the author's imagination ends and cutting-edge research begins.

Cronin is also unafraid to create moments of striking surrealism: a waterfall at the edge of the world that flows upwards is a particular highlight. And there are moments of extreme disorientation, sudden ruptures that at first suggest missing pages, but are in fact all part of Cronin's grand thesis.

Some seasoned sci-fi fans may guess where the book is heading, but for many readers, possibly most, the third act reveal will be truly astonishing. What seems to begin as a belated post-*Matrix* riff on the nature of reality becomes an exploration of creativity and creation, memory and freedom, grief and love. Plus, it manages all this while telling a tale that feels familiar, even though it is only the broadest outline that you will recognise.

By the end of *The Ferryman*, you may very well find that you were as clueless as Bennett all along. ▮



Old people on the island of Prospera are ferried off to be regenerated

THANH THUY/GETTY

Neil McRobert is a writer and podcaster based near Manchester, UK

For another unusual take on ageing, see the sci-fi column on page 36

A world of irritation

An excellent guide unpicks the complexities of how our immune system causes allergic responses, says **Elle Hunt**

Book
Allergic
Theresa MacPhail
Allen Lane



Asthma symptoms can be down to allergies, but they can also be caused by other conditions

PEOPLEIMAGES/ISTOCKPHOTO/GETTY IMAGES

WHILE driving through his New Hampshire hometown one August morning in 1996, 47-year-old salesman James MacPhail was stung by a bee – and died.

He hadn't known that he was allergic to bees, but, having been stung a few weeks previously, his immune system recognised the threat and redoubled its response, creating fatal anaphylactic shock.

His daughter Theresa wondered at the paradox of having such a strong physical response that "in addition to protecting you… it can kill you". What made one body collapse at a threat easily brushed off by another? How could someone react so differently to the same trigger just a few weeks later?

Decades after her father's death, MacPhail, by then a writer and medical anthropologist, set out to investigate this through the lens of her own struggle with respiratory sickness. The result is *Allergic: How our immune system reacts to a changing world*, a thoroughly reported, memoir-style work that shows both MacPhail's personal connection to her subject and its wide-reaching relevance.

For a while, she was satisfied with her own vague diagnosis of "allergies", taking it as proof of the scale of the problem. About 40 per cent of the global population have allergies, from minor irritations to life-threatening reactions. By 2030, she says, experts predict this figure will reach 50 per cent.

There is now widespread awareness and acceptance of the potential seriousness of allergies, hastened in the UK after two people died from anaphylaxis after eating at sandwich shop Pret a Manger.

MacPhail explores how slack approaches to packaging and policies (and stereotyping of people with allergies as weak) endanger lives. But even as allergies are recognised, their parameters aren't consistently described, or even understood, she says.

This means that an asthmatic reaction, say, can be caused by many conditions and doesn't always indicate an underlying allergy. The ambiguities of self-reporting, definitions and interpretation of test results also complicate analysis.

Likewise, discussion of food sensitivity and intolerances can trigger the "nocebo effect". As MacPhail writes: "If a person anticipates that they will feel worse after they ingest the foods they think are causing their symptoms, they actually do."

Early humans might have had asthma and anaphylaxis in response to snake or insect venom, but they weren't likely to have experienced hay fever or food allergies. Tracking their rise over the past 200 years, MacPhail highlights another complication: the impact of environment and lifestyle. From the first medical description of an allergy in 1819, our immune systems have adjusted to our changing world, not always proportionately. Pollution, chemicals and antibiotics play havoc with them, adding to the costs of global public health. For example, the number of children with eczema has doubled between 1997 and 2018, MacPhail reports.

Urbanisation and the climate crisis are influencing individual experiences of allergies, mostly for the worse, as those with hay fever know well. As MacPhail warns, in some ways those individuals are canaries in the coal mine.

As a former journalist with a wide interest in public health, MacPhail makes an engaging guide through an often elusive subject. Led by curiosity, informed by personal experience and good reporting, *Allergic* has plenty to offer readers interested in the interplay between individuals and their environment, and the fraught, fluid line between sensitivity and intolerance we tread. As MacPhail says, "we're all in this increasingly irritated world together".

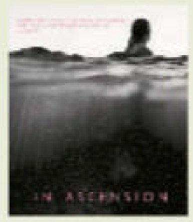
Elle Hunt is a writer based in Norfolk, UK

New Scientist *recommends*



Alison Flood
Views editor
London, UK

I have just finished Martin MacInnes's ***In Ascension***, one of the best sci-fi novels I've read for ages. It is narrated by Leigh, a marine biologist who joins a team exploring a 36-kilometre-deep trench in the Atlantic Ocean. Around the same time, NASA engineers make a breakthrough in propulsion tech that will transform space travel, and Leigh is hired by a secretive space agency.



I'm not sure I've read a book about space exploration that also felt so grounded in the human world, or one about the origins of life on Earth that also looked so far into the future. My mother, who I've already forced it on, agrees.

This week, I also visited **Dopamine Land** in London (ends 25 June), a multisensory event intended to "fire your happiness hormone levels" through a mix of pillow fights, a lights-and-mirrors room and a digital forest complete with woodland smells. Let's just say, I think my dopamine would have seen a greater spike had I not been accompanied by my children.

The sci-fi column

Big shots

Big shots Suppose the megarich can rejuvenate – but it makes them grow to titanic proportions? Nick Harkaway draws on Greek myth and noir in a fabulous thought experiment that reflects our own fixation with "making it big", says **Sally Adee**



Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee

Book
Titanium Noir
Nick Harkaway
Corsair/Hachette



SEPIA TIMES/GETTY IMAGES

Francisco Goya's take on the myth of the Titan Cronos eating his son

WHAT a strange, placeless place Nick Harkaway has created in his *Titanium Noir,* a mix of speculative sci-fi and noir. The shoreline city of Chersenesos juts into an alpine lake – possibly an oblique nod to a future climate that has driven humanity far up the mountains.

But in this future, discussions of climate are curiously absent. There are bigger problems. Literally. That alpine lake is called Othrys, which classics nerds will spot as the name of the mountain that housed the Titans of Greek mythology.

The Titans this time, however, aren't pre-Olympian gods, but speciated rich people – speciated because whenever they get older than they would like, or critically injured, an exclusive, wildly expensive treatment returns them to teenage rude health. The one catch: their bodies become 20 per cent bigger and denser. Cash is the only limit on repeating the procedure, but you add another 20 per cent each time. It is a lesson in compound interest: after a few rounds, sheer scale means you cease to register as wholly human. Harkaway explicitly calls this strange new elite "Titans".

This is the society in which Cal Sounder, a private eye, is called in to investigate shady activity that may have extra-large fingerprints. Actual police can't get involved because when rich people own everything – which, of course, they do because the richest never die – what does "police" mean? Or even "society"? But when a Titan turns up as a victim instead of a perp, life gets extra complicated. Especially for a private eye whose love interest is on the taller side.

> **"Harkaway understands it won't just be bodies that morph; minds will stop being like ours in fundamental ways"**

Old age has undergone recent redefinition. Rather than being an inescapable fact of the human condition, in some corners of science it is being recast as a chronic disease to be cured. Drugs like metformin and rapamycin are being pressed into service in trials to see if they can mitigate the ageing process.

Ethicists point to all that could go wrong, but downsides get abstract very fast. Concerns about inequality and other social consequences fade in the face of the many personal benefits we imagine for ourselves.

Harkaway has understood two things about the implications of such a development. Capturing the disorientation and social stagnation that would ensue is only possible by a fusion of the most fatalistic genres – Greek mythology and noir. You see, Cal's role isn't to solve crime, but to provide the illusion the game isn't over. "There's no game because the house owns everything," he says. Like the mythical Cronos, who ate his children to avoid being usurped, the new Titans "eat" the future – by owning it.

Harkaway also understands that it won't just be the bodies of the Titans that morph. Their minds will fundamentally stop being like ours: a 300-year-old will forget more than you ever remembered. So their motives will become as unfathomable as those of the primordial gods of ancient myth.

It is Sounder's persistence – like Sisyphus, doomed to push that intractable boulder up an eternally ungrateful mountain – that gives this deeply philosophical story its oomph. So do the other characters, who, as in other Harkaway books, arrive fully formed and linger long in the memory. Luckily, Harkaway has hinted that this won't be the last we see of Chersenesos.

And it's a good thing, too, because I have never been so defeated by an ending. But then I went back and started the book again. Sisyphus, innit. ■

Sally also recommends...

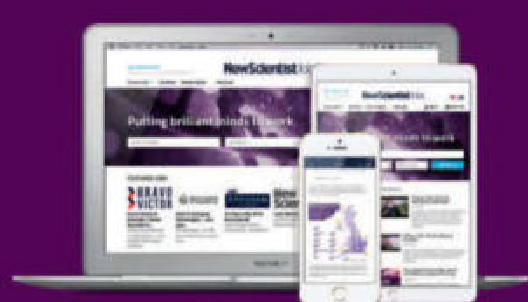
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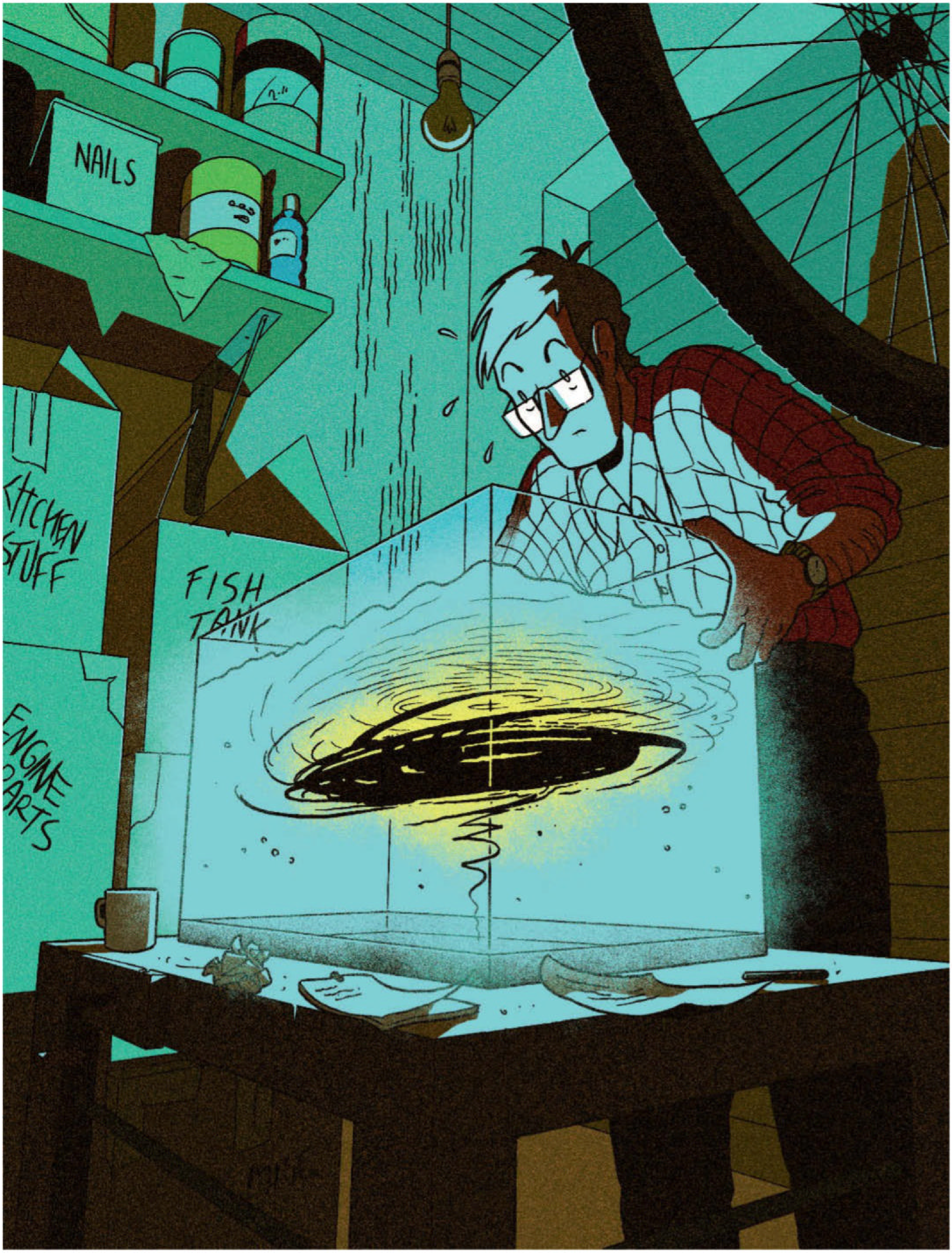
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RUBY FRESSON

Tabletop universe

Physicists are conjuring crude models of the cosmos in glass tanks and tubes. Can these simulations reveal the secrets of space and time, asks **Jon Cartwright**

GERMAIN ROUSSEAUX owns what looks like a very long and very narrow fish tank, minus the fish. At the bottom, in the middle, is a plastic ramp. When he switches on the apparatus, waves sweep along the tank and pass over the ramp, speeding up as they do so. This, he says, is a black hole.

Well, not a black hole in the common sense. Not a star-gobbling pit in the fabric of space-time. Rousseaux's experiment at the Institut Pprime in Poitiers, France, is a physical model of how the immense gravity of black holes can suck in waves – conventionally light waves, but in this case water waves – so they can't escape.

It is what is known in the trade as a "gravity analogue", and it is far from the only one. Over the past 15 years, researchers have created dozens of these tabletop models – despite the mutterings of many theorists, who are sceptical that such simple experiments can tell us anything about the universe's most darkly mysterious objects.

Yet some researchers have begun to simulate more and more aspects of the universe, including even the entire infant cosmos. Now, some of them believe the models are giving us insights into the deepest nature of reality. There is even a suggestion that the speed of light, that hallowed constant of physics, might not be fixed after all. "Applying insights from these models would imply a radical shift in view," says Rousseaux. But can we really rely on tanks of liquid to solve the mysteries of how the universe works?

One thing is for certain: there are many such mysteries to deal with. We don't fully understand how the universe began or why it looks the way it does today, with stars and galaxies strewn in every direction with an unlikely evenness. Then there are those two enormous unknowns, dark matter and dark energy. No one knows what these entities are, but the former seems to make up the bulk of the universe's matter, while the other appears to be driving it to expand at an increasing pace.

All these issues are to do with the nature of space and time, and we have Albert Einstein to thank for our modern take on those. In 1905, his special theory of relativity established that the speed of light in a vacuum is a constant, implying that space and time – the way we measure speed – must be flexible, depending on who is watching. Then, in 1915, he went a step further with general relativity, equating the fabric of space-time with gravity. By default, space-time is flat, in the sense that anything passing through it travels undisturbed in a straight line. Introduce matter, though, and space-time warps and things begin to drift down its slope. This, said Einstein, is what we perceive as gravity.

A strange glow

Normally, gravity is a weak force. But pile more and more matter into a small volume and space-time can be bent into the bottomless chasm that is a black hole. Anything that strays too close, past a threshold known as the event horizon, will fall in and never get out. We know that black holes are common, littering our galaxy by the million. Yet they remain poorly understood.

One of the strangest predictions about them came from physicist Stephen Hawking. Back in the 1970s, he was thinking about black holes and the empty vacuum of outer space in the context of quantum mechanics. This theory treats a vacuum as a froth of low-level quantum fields: not quite nothing, not quite something. Hawking showed that a black hole makes this picture even weirder. It compresses the vacuum quantum fields, making them strong enough to manifest as proper matter and radiation. Inside the event horizon, the negative component of the field, which is associated with antiparticles, predominates; outside, the positive component, made of particles, can radiate away. In short, Hawking predicted that black holes aren't totally black: they glow.

Ever since, theorists have been beguiled by this hypothetical glow, called Hawking radiation. No one has ever detected it from a real black hole and it is likely that no one ever will, because it is predicted to be so incredibly faint.

Still, could there be a way to find evidence of it elsewhere? In 1981, physicist Bill Unruh at the University of British Columbia in Vancouver, Canada, came up with the idea of making a laboratory model of a black hole to see if it might produce an analogue of Hawking radiation. After all, space-time is a bit like a fluid and quantum fields are like waves, so it ought to be possible to create waves in a liquid that are analogous to Hawking radiation.

Unruh's proposal inspired many physicists to make such models, including Rousseaux. Start with a fluid, which represents space-time – for Rousseaux, this is water pumped steadily along his tank. Then modify the flow by, for example, inserting an obstacle. The effect is like warping space-time. If the change in current is strong enough, one side of the obstacle acts as a black hole, so that water waves travelling towards it can't travel fast enough to rebound backwards again. Meanwhile, on the other side, waves can't get past the obstacle in the first place. Here, the obstacle acts like the theoretical opposite of a black hole, a white hole, into which nothing can enter. ›

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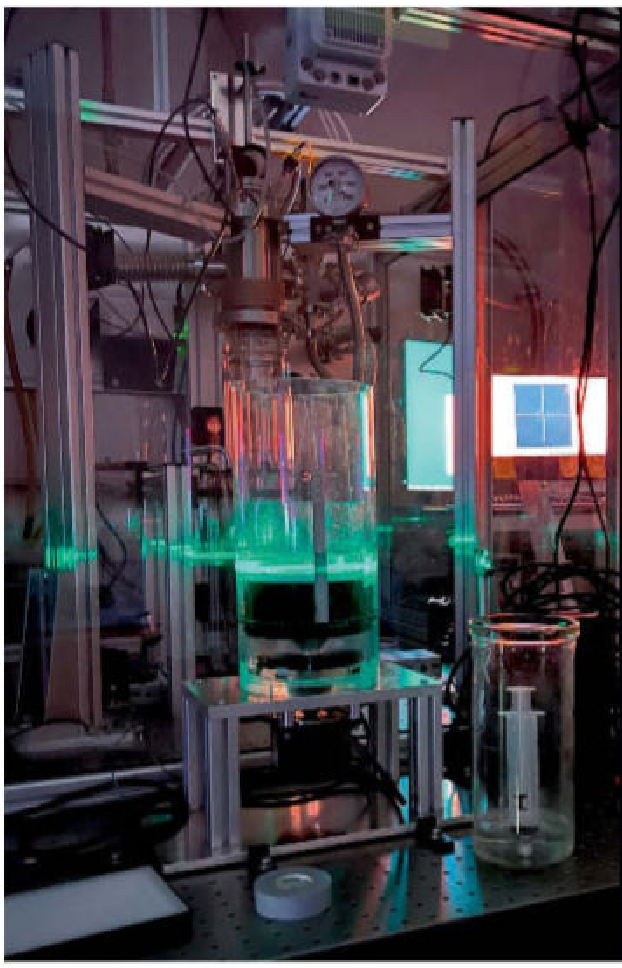
Except, that is, for the gaze of the experimenter – and herein lies an important distinction between analogue black holes and the real thing. Analogue black holes have horizons – points of no return for water waves and other things whose maximum speed is low – but not event horizons, which are impassable for absolutely everything, including the fastest thing of all, light. "Like God," says Rousseaux, "we can observe the inside and the outside."

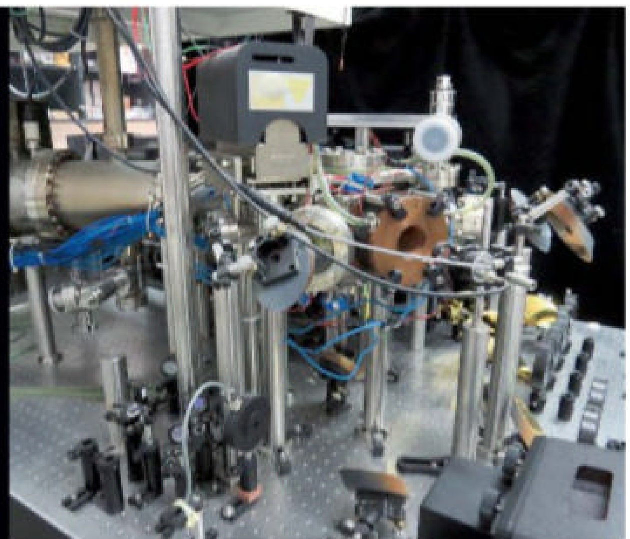
When Rousseaux and his colleagues created one of their first analogues in 2008, they did see a hint of something akin to Hawking radiation. They focused on the white hole horizon because, for technical reasons, it is easier to study water that is slowing down than speeding up. When those waves approached the white hole's horizon, they didn't crawl to a stop, as you would expect. Instead, some bounced back, inverted. In these reflections, the propagating crests and troughs had switched places; mathematically speaking, their relative frequency seemed to turn from positive to negative. As Hawking's equations predicted, the outside of the white hole's horizon had generated a negative field – in this case, one made of water waves.

Rousseaux did worry that what he saw was a false signal, a type of harmonic wave that big enough waves can generate by themselves. But within a year or so, several other groups were working on analogue black and white holes. By 2016, Rousseaux had built a refined set-up that generated waves just a couple of millimetres tall, small enough to avoid harmonics, and had seen the same Hawking radiation-like effects.

> "Space-time analogues could provide insights into the nature of the very early universe"

Meanwhile, Ulf Leonhardt, an early collaborator of Rousseaux's who is now at the Weizmann Institute of Science in Rehovot, Israel, had been pioneering space-time analogues in a seemingly very different medium: optical fibres. Here, space-time is represented by light travelling through the fibres, and of course light is composed of electromagnetic waves. The "obstacle" in this case is a separate laser pulse that warps the properties of the fibres, making the light slow. In 2019, Leonhardt's team used this approach to create an optical white hole horizon clearly flanked by positive and negative light fields.





A space-time analogue made of liquid at the Gravity Laboratory at the University of Nottingham, UK (left). Meanwhile, Jeff Steinhauer's black hole analogue (top) involves supercooled rubidium

L: LEONARDO SOLIDORO/GRAVITY LABORATORY; R: PROF. JEFF STEINHAUER

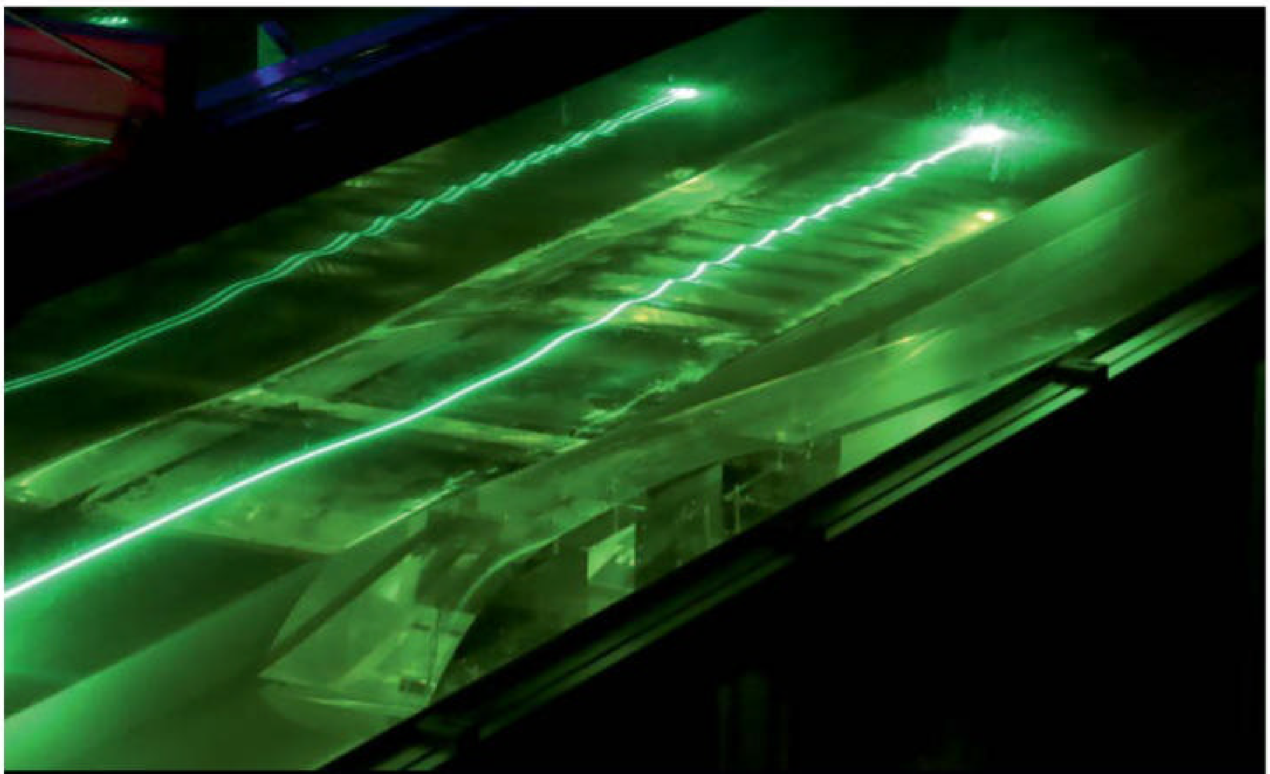
Not far away, at the Technion – Israel Institute of Technology in Haifa, Jeff Steinhauer has developed yet another approach. He takes a microscopic drop of rubidium and cools it to almost absolute zero, whereupon it becomes a superfluid that has strange quantum properties. At such low temperatures, vibrations almost completely cease, making observations much easier. The blast of a laser punctures the drop like a black hole; the atoms fall so fast that they exceed the speed of sound, emitting positive and negative waves in either direction. In 2016, Steinhauer patiently recorded the correlations between these waves, until he convinced himself they were just like Hawking radiation.

These days, the field of gravity analogues is highly competitive and the nuances of what the experiments really show are often questioned by rival researchers. What everyone in the field agrees on, however, is that Hawking radiation is far more general than Hawking himself realised. In any medium that can host waves and have them pass through a horizon, you should see new waves, positive and negative, emitted from either side of the horizon. "Hawking radiation has the same derivation in any system – it's universal," says David Bermudez, a theorist at the Center for Research and Advanced Studies of the National Polytechnic Institute in Mexico City.

An expanding puddle

Buoyed by this, researchers are now being bolder and making analogues of other extreme aspects of space-time. Markus Oberthaler at Heidelberg University in Germany, for example, has been looking at how the universe began. Modern cosmology predicts that, in its first moments, the universe saw a faster-than-light expansion known as inflation. This would have stretched out primordial quantum fields so that their tiny fluctuations seeded the humongous structures, such as galaxies, that we see today.

To model this, Oberthaler and his team took a tiny puddle of potassium superfluid and used magnetic fields to tweak the speed with which waves rippled outwards from the centre. By tweaking them just so, the waves slowed until they never reached the outside at all – a curious effect that mimicked what happened during inflation. Oberthaler's experiment doesn't



Germain Rousseaux's experiment uses flowing water to simulate black holes

GERMAIN ROUSSEAUX

prove inflation really happened, of course. But Silke Weinfurtner at the University of Nottingham in the UK calls analogues such as these a "first glimpse" of how lab experiments could provide insights into the nature of the very early universe, which, until now, has been the domain of theory alone.

Weinfurtner is already exploring further. In her "gravity laboratory", she is surrounded by futuristic glass cauldrons of liquids, illuminated orange and green by lasers that measure the waves within them. In one experiment, she is looking at another prediction of modern cosmology. After inflation, primordial quantum fields are thought to have fed off one another to create "spikes" that manifested as real matter. Last year, Weinfurtner and her colleagues mounted a vessel on a shaking platform to simulate this cosmic period and found that the waves interacted with one another to the same degree as predicted by theory.

For Weinfurtner, the question isn't whether universe analogues correctly mimic the real universe in all respects, but whether they can reveal nuances beyond the scope of theory. After all, theories tend to reduce the complexity of the universe to a fixed number of parameters. There is a chance that analogue experiments will give physicists a better idea of what to look for in the real, messy world to confirm their hypotheses. "That the equations governing our analogues are not quite the same as the real thing disturbs a lot of people, but actually it makes it really interesting," she says. "Can we simulate beyond what we can calculate?"

One area where this might play out connects back to Hawking radiation. It is predicted to appear to us as faint radio waves, but that is after it has undergone stretching to escape the black hole's gravity. When first emitted, it must have had an infinitesimally small wavelength. But the rules of quantum mechanics don't permit such boundless reduction. There is no accepted solution to this paradox.

In analogue black holes, there are none of these impossible wavelength shifts to fret over. In the vacuum of space, light is supposed to always travel at the same speed. But in nearly all materials – including the water in Rousseaux's tanks – the speed of light depends on its wavelength. In practice, then, a wavelength can never be zero because the speed of the ray would change to prevent that.

This could be seen as a deficiency of analogue gravities. Or, says Leonhardt, it could be that the theory describing real space is what is at fault. Maybe the speed of light in a vacuum isn't always a constant. Maybe, at the smallest quantum scales, it changes – keeping the wavelength of astrophysical Hawking radiation within quantum bounds.

Is there a risk of reading too much into these analogues? Perhaps. This isn't the first time, of course, that researchers have used models of some sort to study things that are too small, too big or too complex to study directly. But these are typically computer simulations or scaled-down physical models. The difference with analogue gravity experiments is that the model is physical, but made of something rather different to the thing being studied. Still, in models of all kinds, there is always an assumption that the correspondence between the model and the real thing is valid – which makes any conclusions provisional.

Watery phenomena

Since no one has ever directly observed a real black hole, ultimately we can never be sure that analogue black holes are a good guide to the real thing. But for Leonhardt, the fact that gravitational phenomena can be seen in fluids, optical fibres and other media is no accident. Maybe the reverse is also true: maybe space-time behaves more like an everyday material than we usually care to think.

One phenomenon that occurs in everyday materials is the Casimir effect, a subtle force that exists between objects when they are separated by exceptionally small distances. Named after physicist Hendrik Casimir, who first predicted it in the late 1940s, it arises because objects in close proximity limit the ways in which quantum fields can fluctuate between them; as a result, they are pushed together.

In January this year, Leonhardt argued that the same theory that describes the Casimir effect in materials can be applied to the space-time of the universe as a whole. It was a leap of faith. But, in doing so, he has calculated that quantum fluctuations can drive the expansion of the universe at just the rate we observe as a result of dark energy. "It was absolutely thrilling to see that the correct order of magnitude came out naturally," he says. Arguably, it shows how analogue experiments can provide new ideas.

For decades, many cosmologists have placed their hope in ever more abstract theories and colossal experiments. The idea that progress could instead come from humble apparatus like tanks of water is, for many, a stretch. But, as Einstein showed, sometimes progress requires abandoning deeply held convictions. "As scientists, we have a choice," says Rousseaux. "To be revolutionary – or not." ∎



Jon Cartwright is a science writer based in Bristol, UK

Where the waters run free

A visit to Europe's only wild river national park highlights why such places are worth fighting for, reports **Graham Lawton**

WHEN you see the abandoned construction site, it isn't hard to marvel at what could have been. We floated round a bend in the river on our raft and there it was: two colossal artificial banks beneath scarred hillsides, stranded diggers and cement hoppers.

These are the forlorn remains of the Kalivaç dam project on the Vjosa river in Albania, which has been dubbed "Europe's last wild river". If the developers had had their way, this would now be the site of a 43-metre-high hydroelectric dam with a vast reservoir behind it. Instead, in March, the Albanian government declared the entirety of the Vjosa and many of its tributaries a wild river national park, the first (and probably last) of its kind in Europe – saved in perpetuity from a fate that has befallen too many of the rivers in this part of the world.

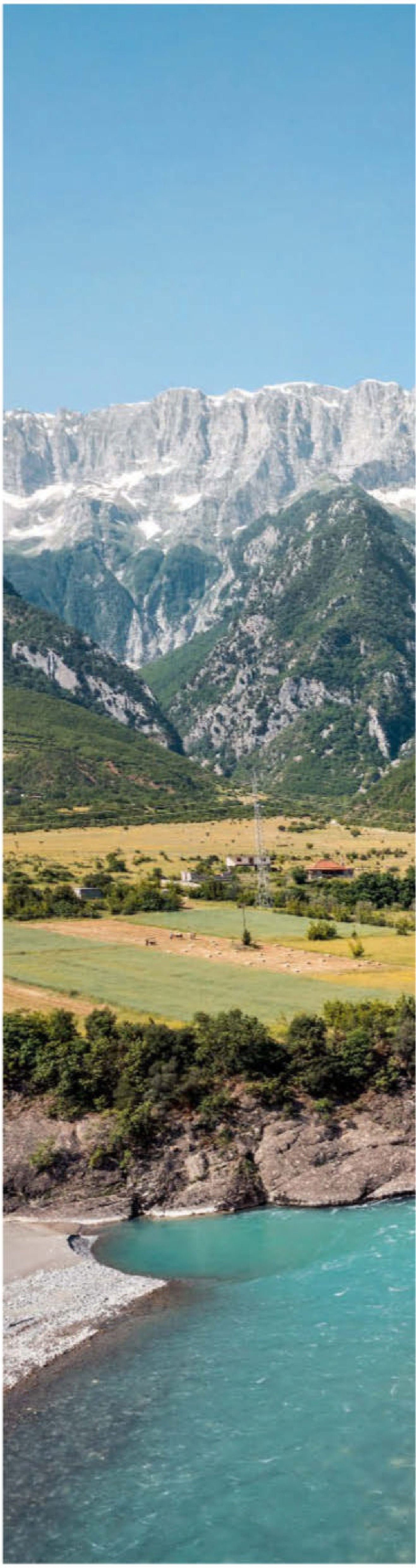
The Vjosa is special because it is entirely free-flowing. Aside from the remains of the Kalivaç project, there are no dams, barriers or artificial banks. It will now stay that way. Mostly.

Dams generate hydroelectric power, but are disastrous for biodiversity and other crucial ecological gifts rivers bestow upon us. So the saving of the Vjosa is a big win for nature – including the critically endangered Balkan lynx and European eel – and an inspiration for other river conservation projects. It is also a rare bit of good news against the backdrop of the shocking state of many of the world's rivers. But the battle to save the Vjosa isn't quite over yet, as I saw for myself when I visited in March.

All rivers used to be free of human-made impediments, of course, but few are now, especially in Europe. "That's what rivers do – they flow," says biologist Olsi Nika at EcoAlbania, an NGO based in Tirana that has been battling to save the Vjosa. "If you block the flow, it's not a river. From the flow are depending a lot of other ecosystem features and ecosystem services, like fish migration, sediment flow, natural purification."

Yet humans have long interfered with this natural state of affairs (see "Global free-flows", page 45). Many of the world's rivers, especially those in more densely populated regions, have been impeded by dams or other barriers to enable transport, irrigation, water supply and, more recently, to generate hydroelectric power. The result is that free-flowing rivers are increasingly rare, with their many upsides often overlooked in the rush to generate green electricity as part of the shift to low-carbon economies.

The giant dam planned for the Vjosa – which rises in Greece and flows for 272 kilometres, via Albania and into the Adriatic Sea – would have condemned the ecosystem benefits it provides to a watery grave. "This is the last river of this size [in this region] that is fully natural," says Andrej Sovinc at the International Union for Conservation of Nature (IUCN), who is based in Ljubljana, Slovenia. It is now protected not just from the threat of dams, but also gravel



LUKAS BISCHOFF PHOTOGRAPH/SHUTTERSTOCK



Albania's Vjosa river, dubbed "Europe's last wild river"

extraction and other damaging activities.

With the dam in place, sediment would have backed up against the structure, leading to severe sediment starvation and erosion downstream, and shrinkage of the river's delta on the Adriatic coast. Migratory fish such as European eels and salmon would have been unable to get past it. The dam would also have turned 14.5 kilometres of river upstream into an 18-square-kilometre reservoir. "Rivers can drown too," says Ulrich Eichelmann, the CEO of Vienna-based NGO Riverwatch, which was part of the campaign to establish the national park.

There would have been other impacts too. "Upstream of a dam, you get kind of a lake system that is completely different from what it was before, populated with completely different species," says Ulrika Åberg of the IUCN in Gland, Switzerland. "And downstream, you also completely change."

Some dams create a uniform flow downstream, which homogenises the river system, destroying seasonal pulses of water that many fish use as cues for breeding or migrating, and making the habitats less variable. "You often get a very monotonous system that doesn't have a large variety of riffles and pools and different morphological features that are important for the ecosystem," says Åberg. Other dams generate electricity by day and store water at night, which leads to a phenomenon called hydropeaking, where the level of the river can rise and fall several metres over each 24-hour cycle. "There are not many species that can adapt to that," says Åberg. The Kalivaç dam was going to operate with a daily hydropeaking system.

Dams can also affect the temperature of the water, again disturbing the natural habitat. "Hydropower is renewable, but it's not green because of the damage it does – it is irreversible," says Besjana Guri at EcoAlbania. Yet hydroelectric dams are subsidised by the European Central Bank as green energy, says Beth Thoren, environmental action and initiatives director at the outdoor clothing company Patagonia, which bankrolled the campaign against the dam.

The Kalivaç threat surfaced in 1997, when the Albanian government awarded an Italian company a contract to build a 108-megawatt power plant across the lower reaches of the ›

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Vjosa. Albania's post-communist development was largely powered by hydroelectricity and it wanted more. Construction started in 2007, but the project was plagued by financial problems and endless delays and a decade later, with only 30 per cent of the work completed, the government pulled the plug.

Europe's blue heart

The contract was then re-awarded to a Turkish-Albanian consortium. By then, however, environmental organisations, lawyers and scientists were on the case with a multi-pronged campaign to protect rivers in the region, called Save the Blue Heart of Europe. It persuaded the Albanian government to think again. In 2020, the then environment minister, Blendi Klosi, reviewed the consortium's environmental impact assessment and deemed it inadequate. Scientists also argued that, given the extremely high sediment load of the river, the dam would silt up completely in 30 to 40 years, rendering it obsolete and a net financial liability. Together, these damning verdicts killed the project and opened the door to the establishment of a national park.

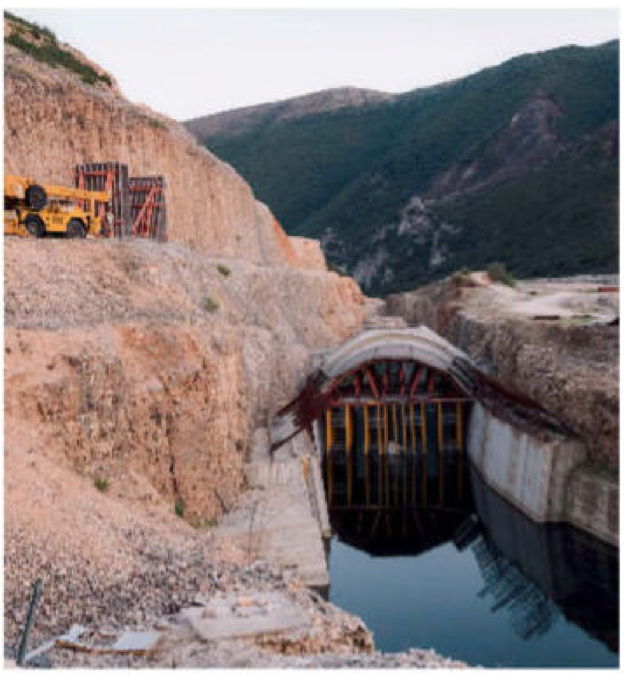
The Vjosa is a sight to behold for somebody like me, unused to seeing what rivers looked like before they were "improved" by humans. Its upper reaches tumble through stunning gorges and canyons and under ancient stone bridges nestled between snow-capped peaks. Lower down, it barrels across a huge gravel riverbed up to 2 kilometres wide. The channel continually splits and rejoins to create ribbons of blue-green water, oxbow lakes and temporary islands on which rare birds nest.

In its last few kilometres, the Vjosa becomes a classic lowland river with a single, languidly meandering channel. After 272 free-flowing kilometres, it eventually empties into the Adriatic Sea at a delta rich with charismatic birdlife, including flamingos, Dalmatian pelicans and Eurasian spoonbills.

"There are no [other] such deltas like the Vjosa in the Adriatic," says Sovinc, a former civil engineer who now works to prevent his old profession from destroying biodiversity. "I think it is one of the few deltas in Europe that is still growing because of natural sediment transport," says Åberg. "You have a lot of sediments coming in, but dams stop that and the delta will be eroded by wave action."

The river itself is a biodiversity hotspot. "There are more than 1200 plant and animal species, some of them only found here," says Sovinc. One important species that depends on the river is the critically endangered Balkan lynx. There are only an estimated 120 individuals left in the world, with 15 or so in Albania. European eels – also critically endangered – would have been severely impacted too, no longer able to access 880 kilometres of the river and its tributaries upstream of the dam. A further 72 of the species found in or around the Vjosa are endangered, according to an impact assessment. This assessment concluded that the dam "would lead to the destruction of one of the most pristine wild river landscapes in Europe".

For now, the national park only encompasses the river itself, its bed and some land next to it, and the same for some of its major tributaries, the Drinos, Kardhiq, Bënça and Shushicë. The total area is 127 square kilometres, about a tenth the size of the average UK national park. It is classed as a category II protected area under IUCN guidelines, the third level of protection below Ia (strict natural park) and Ib (wilderness area). This isn't a slight, but a recognition that the river is inevitably impacted by human activity, such as farming, and also that it has significant development opportunities for sustainable tourism and recreation, says Åberg.



NICK ST.OEGGER

The abandoned site for the Kalivaç dam on the Vjosa river

The next phase of the project aims to extend the park further out onto the floodplain, to some smaller pristine tributaries and to the river delta, which isn't currently included, but arguably ought to be. "The delta is a part of the river," says Sovinc.

That is a huge bone of contention. In 2004, the whole delta was designated as a protected landscape – a lower level of conservation than the wild river national park – but in 2022 the government unilaterally unprotected part of it so an international airport could be built.

Vlora International Airport is intended to be the acorn of a mighty tourism industry on the coast north of the delta. The campaign is far from happy about it and has filed a lawsuit to stop its construction, but was publicly and forcefully told by Albanian prime minister Edi Rama at the inauguration of the park that "the airport will be built" and there is nothing that can be done to stop it. I went there; it is already under construction and due to open to 1.5 million tourists, including from North America, next year.

The airport is very close to a lagoon called Narta where the pelicans and flamingos feed. It is a key stopover on the Adriatic Flyway, a major route for birds migrating between

This feature is a part of our Save Britain's Rivers campaign. For more information visit:newscientist.com/save-britains-rivers



REUTERS/FLORION GOGA



TSADO/ALAMY

Flamingos in the Vjosa river delta (left) and an aerial view of the river flowing through Albania into the Adriatic Sea

Europe and Africa. When I was there in March, there were flocks of swallows bringing summer to the north. Loggerhead turtles nest in the delta's sand dunes and will probably be severely affected by the noise and artificial light, says Zydjon Vorpsi of conservation group the Protection and Preservation of Natural Environment in Albania (PPNEA).

Tourism trap

There is another important wetland about 35 kilometres up the coastline, the Divjakë-Karavasta National Park, where the pelicans breed. Exactly what effect the airport will have on them and the flyway is unknown, says Vorpsi. But the runway could disrupt their commute between the wetland sites and their willingness to live nearby. "Pelicans are endangered and a species very sensitive to disturbance," says Sovinc.

Opinion is divided on whether the airport really is a major threat to the delta. "Even if there is an airport, it has been built on the area which has not the most important conservation value," says Sovinc. Not so, says Nika. "The full delta is part of the river, you can't judge what is important and not important. The most important part of the river is the continuity of its ecosystems."

But the airport may be just the start. "We fear it is actually just the beginning of further infrastructure investment in the area," says PPNEA executive director Aleksandër Trajçe, "because the area there has amazing virgin beaches, amazing wetlands, amazing landscape, so we fear that huge tourism resorts are going to be developed."

There is also the problematic fact that the Vjosa is a transnational river, rising in the Pindos mountains in Greece. Within Greece, much of the Aoös – as the river is called there – and its major tributary the Voidomatis are inside the Northern Pindos National Park, but substantial sections near the border aren't. The Greek government is considering whether to extend the park to protect them.

Dams are also a problem in Greece – not massive ones like the Kalivaç, but small hydropower plants on fast-flowing mountain tributaries. Four are already in operation on tributaries of the Aoös, says Alexandra Pappa at the Mediterranean Institute for Nature and Anthropos, an NGO based in Athens, and there are plans for 45 more. Nobody has modelled what would happen to the Vjosa if they were all built, she says, but her guess is that they would have a negative impact on sediment transport.

Another issue facing the Vjosa is plastic pollution. The bushes and trees lining the lower reaches of the river are festooned with ugly plastic bags, the legacy of a dysfunctional waste disposal system in Albania, according to Gabriel Schwaderer, executive director of the NGO EuroNatur based in Radolfzell, Germany. One of the first tasks for the national park authority is a litter pick, but it will be a mammoth job. Other major hurdles lie ahead. The park needs to have effective management and sustainable tourist infrastructure, such as hiking trails, put in place, says Thoren.

The Vjosa Wild River National Park is a magnificent, if flawed, win for nature, which could be an inspiration for other river conservation and restoration projects, says Pappa. But it also begs an uncomfortable question about our general attitude towards our rivers. At the park's inauguration, Albania's minister of tourism and environment, Mirela Kumbaro Furxhi, celebrated the achievement of protecting this river, but asked a pointed question of the international audience: "What have we done to the others?" ■

Global free-flows

Only about a quarter of the world's great rivers remain free-flowing from source to sea. These include the Congo in Africa (4960 kilometres), the Yukon in North America (3207 km) and the Amazon in South America (5990 km). But these, like many long, unimpeded rivers, are in remote locations.

By contrast, the Irrawaddy (2071 km), the biggest river in Myanmar, is one of the few large rivers to remain free-flowing in a densely populated region. It is the same for the Salween (3244 km), a South-East Asian river running from the Tibetan plateau to the Andaman Sea (*Nature*, doi.org/c5k8).



Graham Lawton is a features writer at *New Scientist*

Meet your future self

Starting to think about your older self helps you make better decisions in the present, finds **Miriam Frankel**

IT WAS with mixed feelings that Hal Hershfield sat down for a video chat with a serial killer. But Hershfield, a behavioural economist at the University of California, Los Angeles, believed Pedro Rodrigues Filho might teach him something about how we can all make better decisions.

Rodrigues spent a total of 41 years in prison for murdering 71 people, and other crimes. In their conversation, he described to Hershfield how, one day, he dramatically changed his mindset. While in solitary confinement after killing a fellow prisoner who attacked him, he said, he spoke to God and vowed to change.

Following his second release from prison, in 2018, Rodrigues claimed to have stopped killing, started exercising and began educating others about the dangers of crime on YouTube. "I consider myself to be a new person now," he told Hershfield.

This dramatic change was "a walking example of how we can be different people over time", says Hershfield. In his book, *Your Future Self*, Hershfield shows that people who feel close to their future selves – and realise they may be different to their present selves – make better decisions, such as exercising and staying on the right side of the law. They tend to have better university grades, superior finances and greater well-being.

Unlike Rodrigues, you don't need a religious epiphany to make such a change. Hershfield is testing various techniques to allow us to engage with our future selves – including writing them letters and even talking to them in virtual reality – that could transform not only how you relate to yourself, but also how you behave in the here and now.

We are surprisingly bad at taking the future into consideration. While you might know someone who is stuck in the past or others who always live for tomorrow, this isn't the norm. "Overall, there's a tendency for us all to be present oriented," says Marc Wittmann, a psychologist at the Institute for Frontier Areas of Psychology and Mental Health in Freiburg, Germany. The present is concrete and often "bodily oriented" – with decisions driven by physical feelings such as hunger or anxiety – while the future is more abstract, he says.

Focusing on the present is why we so often fail to stick to diets and struggle to keep New Year's resolutions: future goals simply aren't as vivid or appealing as another biscuit right now. Research by Wittmann and his colleagues demonstrated that when people are offered either £100 immediately or £125 in a week, most opt for the smaller, instant reward. This is called temporal discounting, meaning we essentially apply a discount to rewards in the future – failing to take our future selves into consideration.

Hershfield wanted to find out whether this bias could be seen in the brain. Two papers based on data from functional MRI and PET scans from various studies have shown that areas in the middle of the brain's cortex, including the medial prefrontal cortex and the rostral anterior cingulate cortex, tend to be more active when we think about ourselves, compared with when we think about others. So, Hershfield wondered, what about when we think about our future selves?

He and his colleagues asked participants to lie down in an fMRI scanner and make judgements about various words, such as "funny" or "honourable", in relation to their current self, their future self or one of two actors, Matt Damon or Natalie Portman. When people thought of their future self, there was less activity in the medial prefrontal cortex and the rostral anterior cingulate cortex than when they thought of their current self. In fact, the brain activity associated with their future self was similar to that resulting from thinking about the celebrities.

There were individual differences. The more disconnected people felt from their future selves, and the more this showed in the brain scans, the more likely they were to engage in temporal discounting in a task a week later. It seems our future selves can literally be strangers to our minds. This was a small study, but experiments by Hershfield and others have reported similar results.

Thinking about the future is more important than ever. "When life expectancy was lower, we didn't need to think very far ahead," says Hershfield. "But now, if you are in a developed nation, you can expect to live a decently long life – and that means you've got to think about the future."

We may not want to. When we are younger, the very far future contains ageing and ›



PETE REYNOLDS

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death, topics we are often keen to avoid. And even if we force ourselves to think about the future, we often fail to do so in a meaningful way, since we tend to have a poor understanding of what our future selves will be like (see "Peak wisdom", right).

Some people are naturally more connected to their future selves than others. One sign of being disconnected, according to Fuschia Sirois, a psychologist at the University of Durham, UK, is procrastination. "People who are prone to procrastination prioritise feeling good now over pushing through emotional difficulties around a task to accomplish something their future selves can enjoy," she says. Her research shows that procrastinators tend to struggle with negative emotions, but also have difficulties thinking about the future.

Procrastination is linked to poor health and mental health problems. "There's a whole emotional dynamic that happens after people procrastinate. You start to feel bad, experiencing shame and guilt," says Sirois. "And that drives further procrastination." A better approach to difficult tasks, she says, is self-compassion. People who have compassion for themselves typically don't feel as bad about procrastinating and do it less.

"I thought it would be cool to have people meet a hologram of their future selves"

In a similar vein, Wittmann has shown that people who report feeling mindful also tend to be more future oriented. This may seem paradoxical, since mindfulness is all about being in the present. But mindfulness helps us control emotional and physical urges, which is useful when planning for the future. "Mindfulness is a proxy for self-regulation capacity," says Wittmann.

On top of this, Hershfield and his colleagues have found that people who feel continuity with their future selves are also more likely to be humble and behave in an ethically responsible way. After identifying all of these benefits, Hershfield began thinking about whether he could design ways to make people more connected with their future selves.

"I had started seeing holograms being used in music performances," he says, "and in one of my lab meetings, I mentioned it would be quite cool if we could do something similar with our future selves… that is, somehow have people meet a hologram of their future selves." Someone else suggested he talk to the researchers in the virtual reality lab in the building next door.

That chat led to Hershfield and his colleagues setting up a series of experiments. They ran pictures of people through a program that could realistically age them to create older avatars complete with age spots, grey hair and wrinkles. They then created a VR program in which people could meet their current self or their future self in a virtual mirror. After people had completed the task, they were asked to answer a series of questions, including what they would do if they received $1000 right now. Those who had interacted with their future selves were significantly more likely to want to save money than those who met their current selves. "What [Hershfield] is doing is making your future self less abstract," says Wittmann. "It makes you think more about yourself and get more empathy towards yourself."

Since this initial study, the findings have been repeated in a variety of situations. Jean-Louis van Gelder, a criminologist at Leiden University in the Netherlands, used a similar VR set-up to let a small group of convicted offenders, some in prison and some on probation, interact with their future selves – including receiving advice from them. One participant found it so disturbing that he left the experiment in tears, recalls van Gelder.

Many criminals are extremely focused on the present, while failing to consider future consequences. "What we are focusing on here is a group that's so extremely [temporally] short-sighted," says van Gelder. "So, theoretically at least, they have so much room for growth." After just one session, participants typically felt closer to their future selves and, after the sessions, many also reduced alcohol use and overspending.

You don't need access to VR equipment to



Imagining a fit older you can help you achieve that goal by exercising more

NORIKO HAYASHI/PANOS PICTURES

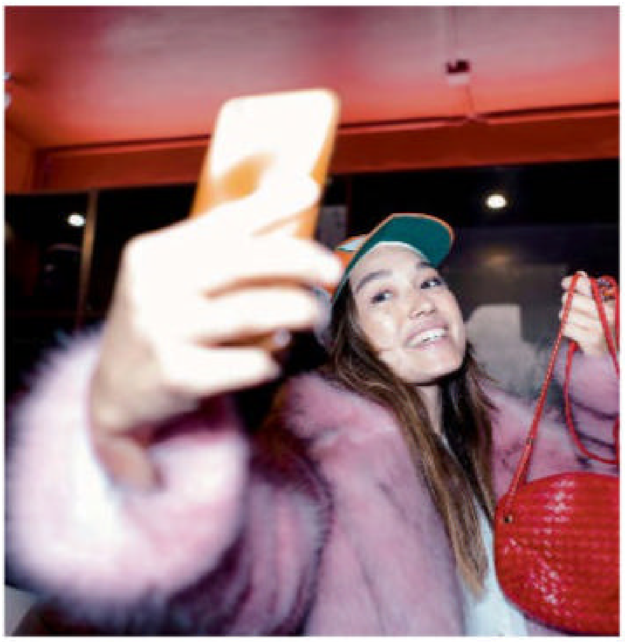
PEAK WISDOM

Psychologists often use the Big Five model to capture differences in personality, dividing it into five distinct traits: extroversion, emotional stability, agreeableness, conscientiousness and openness to experience. Research has shown that levels of these traits actually change moderately over a person's lifetime: on average, people become more emotionally stable, conscientious and agreeable later in life.

But we don't necessarily realise this. Instead, many of us like to imagine we have reached peak wisdom, no matter which stage in life we are at. In one study, researchers asked nearly 20,000 people how they would have described their personality 10 years ago, then asked the same people to predict their personality traits 10 years into the future. They discovered that people thought they had changed a lot in the past decade, but didn't believe they would change as much over the next one.

This matters when it comes to decision-making. If we think our future self will have the same values and preferences as we do now, we might splurge all our savings on a sports car in the belief that it will give us something to do when we are retired. But, in reality, our future self may well have tired of cars and would have preferred a bit more cash in their pension pot. If we realise that our future self may well differ from our current self, we can potentially make better decisions for them (see main story).

You may want that purchase now, but what would older you think?



WESTEND61 GMBH/ALAMY

become closer to your future self. Apps like FaceApp or filters on social media that can age you can do the trick. In one study, Hershfield and his team asked working adults how much they would hypothetically like to contribute to a retirement pot. As they made the decision, some participants saw a picture of their future self while others saw an image of their current self, based on a photo they had uploaded. Those who saw their present selves were willing to invest about 2 per cent of their salary, while the participants who saw their future selves opted for 6 per cent.

You could also try good old-fashioned letter writing. In another experiment, Hershfield and his colleagues created an app that allowed Mexican banking customers to write notes to their retirement-aged selves. Those who did were significantly more willing to sign up for an automatic savings account. Other research shows that people who wrote letters to or from their future selves, one year ahead, during the ongoing covid-19 pandemic experienced fewer negative feelings. Ideally, you should also let your future self respond to the letter, says Hershfield. That increases the effect.

Before you rush off to put all this into practice, perhaps by printing an age-progressed image of yourself on your credit card, Hershfield thinks we should save this technique for big life decisions, such as buying or renting a property, or deciding our contribution to a retirement fund. "Those may be moments where it's worth having a conversation with your future self," he says.

When it comes to everyday, repeated decisions – such as whether to go to the gym or have a glass of wine after work – it may be more useful to commit to a strategy and make it difficult to mess up. This works for Hershfield, at least, who locks up his phone each evening. Other than that, the main thing he does is to ask himself how his future self would feel about different outcomes when he is faced with particularly tough decisions.

George Loewenstein, a behavioural economist at Carnegie Mellon University in Pennsylvania thinks Hershfield's work is "compelling". Nevertheless, he says we shouldn't take the findings to mean that a change in mindset alone can lead to a massive boost in how much people save for retirement. The current economic system makes it very difficult for most people to save money, he says. "The moment we say people aren't saving enough for retirement, we're just taking our flawed system as a given and putting the onus on the individual."

Another possible drawback is that an obsessive relationship with our future self might become toxic – making us unhappy, selfish and, eventually, full of regrets. In their book *The Time Paradox*, psychologists Philip Zimbardo and Daniel Boyd suggest that people who are too focused on future goals are less likely to offer immediate help to others.

Hershfield is also quick to point out there is such a thing as too much focus on the future. Being friends with your future self is all about balance. "If you said that you were completely sacrificial to your partner in a way that gave you no ability to get your own independent happiness, then I would say that's not a good relationship", and the same applies to our relationship with our future selves, he says. "The irony there is that you are still doing a disservice to your future self, because you will look back and regret it."

We tend to experience more regret about delaying gratification than about giving in to temptation. At the end of our lives, after all, most of us typically regret what we didn't do more than what we did do. Those of us who aren't serial killers, that is. ■



Miriam Frankel is a journalist and author of *Are You Thinking Clearly?: 29 reasons you aren't, and what to do about it*

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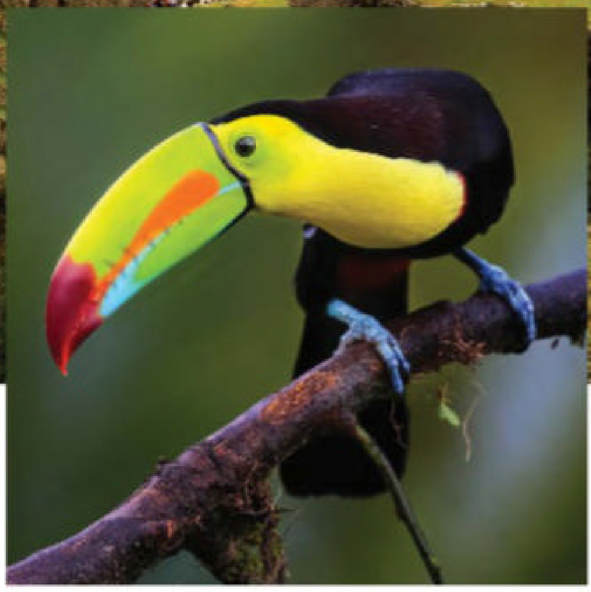


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Immerse yourself in the Inca civilisation's most important archaeological sites, science and history while exploring the beautiful Sacred Valley. On this unique expedition, you will learn how the Incas developed a complex society and used their extensive grasp of science and technology to expand rapidly. They displayed a mastery of stone-cutting, astronomy and mathematics as they created buildings for living and worshipping, and their irrigation, aqueducts and precision control of water supported their high-altitude farming on steep slopes.

Throughout this you will be accompanied by Peter Getzels, Emmy award-winning director, producer and cinematographer, anthropologist, explorer and mountaineer, along with Dr Jean-Jacques Decoster, professor of anthropology at the Universidad Nacional San Antonio Abad del Cusco.



6 November 2023 | 13 days

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Join this amazing expedition where you will experience biodiversity first-hand and delve deep into the science behind it. This trip will encompass a wealth of fascinating ecosystems, including cloud forests, wetlands, primary rainforests, volcanic zones and the rich variety of life in marine reserves and national parks.

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Find out more and explore other fascinating voyages of discovery online at newscientist.com/tours

Puzzles
Try our crossword, quick quiz and logic puzzle p53

***Almost* the last word**
Can a bee far from its hive find its way home? p54

Tom Gauld for *New Scientist*
A cartoonist's take on the world p55

Feedback
A sugary solution and packaging science p56

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p56

60-second psychology

Not such a close reading

More and more of us are turning to audiobooks for our reading, but they may be making us more gullible, says **David Robson**



David Robson is an award-winning science writer and the author of *The Expectation Effect: How your mindset can transform your life*

LIKE many people over the past few years, I have found myself transitioning to audiobooks as my main means of devouring literature. After a day of squinting at my laptop, I find it far more comfortable to "read with my ears" while my eyes are resting. My consumption of new books has doubled as a result – but a recent paper makes me wonder if this will come at the price of my comprehension. When we listen to a text, it seems, we may engage in less deliberative thinking and rely more on our gut feelings to appraise its content.

The study comes from Boaz Keysar and Janet Geipel, both then at the University of Chicago, and it draws from the "dual process model" of mental processing popularised in Daniel Kahneman's best-selling book *Thinking, Fast and Slow*. According to this view of the mind, we have two ways of appraising information. System 1 is intuitive, relying on instinct and feeling. It is quick, but vulnerable to misinformation and cognitive bias. System 2 is analytical: when it is engaged, we think our way through the material step by step. It is more effortful, but also more rational.

Over the past two decades, psychologists have devised various tests to determine which of these two systems a person is using. As one example, consider the following question: How many animals of each kind did Moses take on the Ark?

If you answered two, you were probably only considering the gist of the question, which is System 1 thinking. To get to the right answer – zero – you need to think more carefully about the wording, which would allow you to remember it was Noah who built the Ark, not Moses. That is the kind of analytical process that requires System 2.



GAUDILAB/SHUTTERSTOCK

Geipel and Keysar's stroke of genius was to investigate whether the sensory modality – seeing versus hearing – of the information would make a difference. They found that it did: when answering these kinds of simple-but-deceptive questions, participants were significantly more likely to make errors when the sentences were spoken out loud, rather than written. The researchers repeated the experiment with a greater range of tasks, in more diverse populations. The results were the same: when listening rather than reading, people were more likely to lean on System 1.

A greater reliance on our intuitions could be a problem if we are consuming information that needs logical scrutiny. If I am tackling a book about science, I want to be sure I am fully engaged, not just nodding along to dubious arguments. For this reason, I will return to reading non-fiction with my eyes rather than my ears. But I won't stop listening to novels. If I am revelling in a story, I am quite happy to go with the flow of my emotions while my critical mind takes a break. ▮

60-second psychology appears monthly

Next week
Stargazing at home

These articles are posted each week at newscientist.com/maker

GALAXY ON GLASS

SPECTACULAR WALL ART FROM ASTROPHOTOGRAPHER CHRIS BAKER

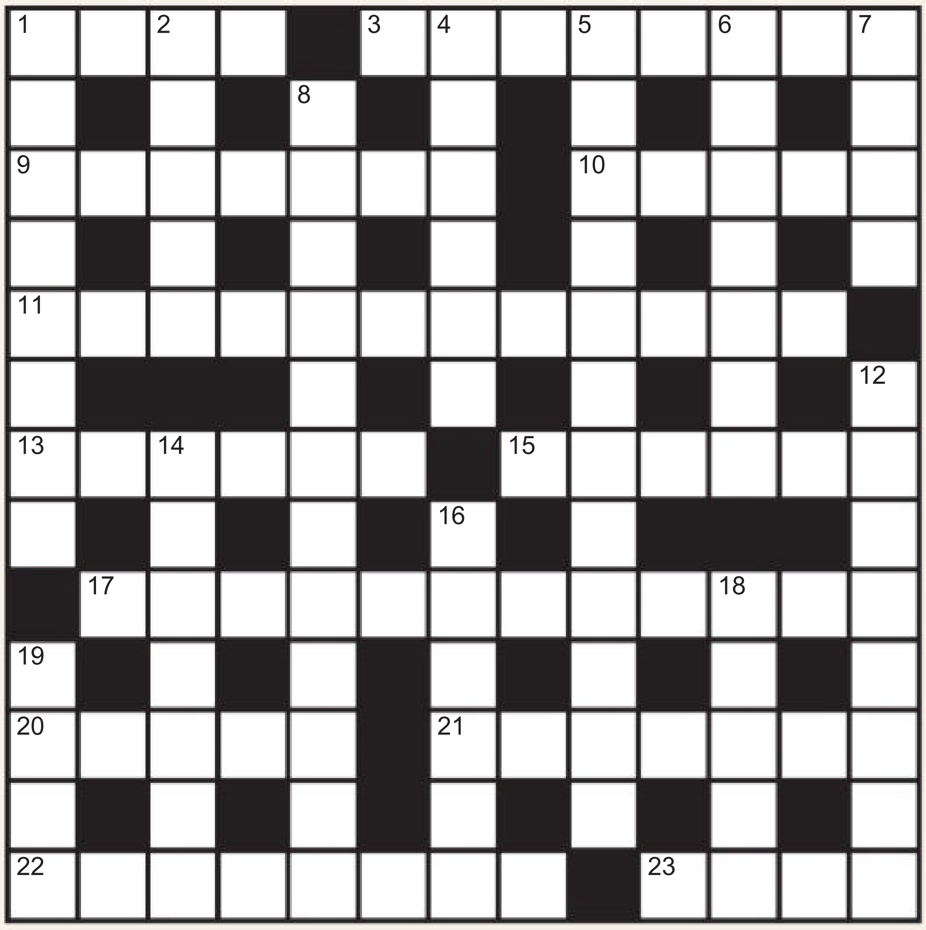


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Cryptic crossword #110 *Set by Wingding*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 As Cockney said, fish feel pain (4)
3/21 I march on beach frantically outside city, a quiet place (8,7)
9 Introduce bakery product – available now! (4,3)
10 Lift up and tear down for audience (5)
11 Lion cub's mum wandering around university – a sign of stormy weather? (12)
13 Weasel contributes to better minestrone (6)
15 Uranium found in government monument (6)
17 A doctor with a student in country where some hormones are made (7,5)
20 Dance between partners – shall I swap regularly? (5)
21 See 3
22 Marine organisms have small pips, according to Spooner (8)
23 Staple food reportedly produced offspring (4)

DOWN

1 Facial features spoiling a clue? Sir! (8)
2 Make noise about one large part of seed (5)
4 Floating pollution at Antarctica sampled (6)
5 Web browser failed to finish article before Margot sent back chemist's analysis (12)
6 Eggs transported via this old bridge, one's dropped (7)
7 Lines spoken, or the preceding lines? (4)
8 At sea, let one create jellyfish, for example (12)
12 Offered gentle encouragement at first, then diamonds (8)
14 Part of brain described by writer with boring initial analysis (7)
16 Foul-smelling source of chemicals in drain needing repair (6)
18 Arkansas almost supported garden structure (5)
19 Snakes like empty packages (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #203
set by Bethan Ackerley

1 How many geological aeons of Earth's history have there been?

2 What is the process by which bodies of water, or parts of them, become enriched with nutrients such as nitrogen and phosphorus?

3 Who discovered nuclear magnetic resonance?

4 The chemical element sulphur belongs in which column of the periodic table?

5 In astronomy, what does CME stand for?

Answers on page 55

Headscratcher
set by Mary Ellis

#223 Setting the right tone

"Not one of your best, is it?" smirked Michael, peering over Leo's shoulder at the portrait he was painting. "The colours are so drab. Who is she?"

"The name's Lisa," said the model, smiling enigmatically from the other side of the easel.

"I'm trying to mix a glaze to perfect the tone of her face," sighed Leo. "But I seem to have run out of paint."

"Yes, about that," said Michael. "I might have borrowed some for a ceiling. In any case, it looks like you've got two brownish dollops there."

"One of them is equal parts yellow, red and blue. The other is five parts yellow, three parts red and four parts blue. But anyone can see her cheeks require 10 parts yellow, eight parts red and nine parts blue!" said Leo.

Lisa sat and listened quietly, with a knowing look in her eye. Or maybe sad, or bored; it is hard to say. But if Leo is to finish his portrait, in what proportions should the two dollops be mixed to produce the right tone?

Solution next week

Buzzing off

If an ant or a bee ends up far from its colony (perhaps by artificial means such as a car or a plane), what will happen to it?

Ken Cheng
School of natural sciences, Macquarie University, Sydney, Australia

Ants and honeybees can sometimes find their way back home after being displaced a good distance, whether by wind or by experimental manipulation.

They do so mainly by their systematic search strategy, which has been much studied in these animals. From their starting point, the insects begin walking or flying in loops, heading off in a different direction each time. At the end of each loop, they return approximately to where they began the search.

If the insect doesn't stumble across their colony, these search loops grow bigger and bigger. The search turns successful when the bee or ant encounters a location

"When heading home, ants and honeybees turn to find the most familiar view, which should indicate the general direction"

from which it recognises the general direction to its home.

Ants and honeybees remember their surroundings. They can learn what the view looks like on their way out foraging and what it looks like on their way back home. When heading back to the colony, they turn this way and that to find the best or most familiar view, which should indicate the general direction home.

To find their way, ants and bees don't have to cross over a path that they have previously travelled. This is because the "catchment area" of a learned view extends beyond the travelled route. The view at an unvisited location, if it isn't too far from a familiar route, will have some resemblance to a learned view. If the resemblance is enough to point out the general direction home, or even guide the insect towards a familiar route, following that direction will eventually lead to success.

To ensure that they learn and remember what the view should be like on the way home, ants and honeybees frequently look back in the home direction as they head away from the colony. If you go walking on a new route by which you must return later, you too can benefit from this bit of wisdom in our insect friends.

An ant or honeybee that doesn't navigate well enough to get home will be lost for good. It won't survive long, and even if it does survive, it won't start a new colony. The workers generally don't reproduce, so all their legacy is with the queen back home.

Peter Gandolfi
London, UK

Bees are certainly capable of flying around 8 or 9 kilometres, but as a beekeeper I would prefer if they didn't because travelling such distances back to the hive will cause them to use up all the nectar they have collected.

Generally, bees seem to visit flowers within 1 or 2 kilometres of their hive. Their navigation uses landmarks, as well as the position of the sun, and is so good that if you move the hive just a metre from its usual spot, the returning bees will fly back to the original site and will be confused at finding their home displaced.

If you need to move a hive, it should be across a distance of less than a metre or more than 5 kilometres, so that the bees don't recognise any of the surrounding area and its landmarks, which could cause them to find their way back to the old site and not the new location.


ROOM THE AGENCY/ALAMY

Could domesticating more rats as pets offset the ecological impact of cats?

This week's new questions

For the love of rats **Given the huge ecological impact that domestic cats can have on their surroundings, why don't we domesticate more rats as our family pets, rather than vilifying them?** ***Adrian Smith**, Leeds, UK*

Early riser **When was the first sunrise on Earth?** ***Craig Hanson**, Rochester, New York, US*

Down south

When travelling by car, why does it feel like I am going uphill when I go north and downhill when I am heading south?

Hillary Shaw
Newport, Shropshire, UK

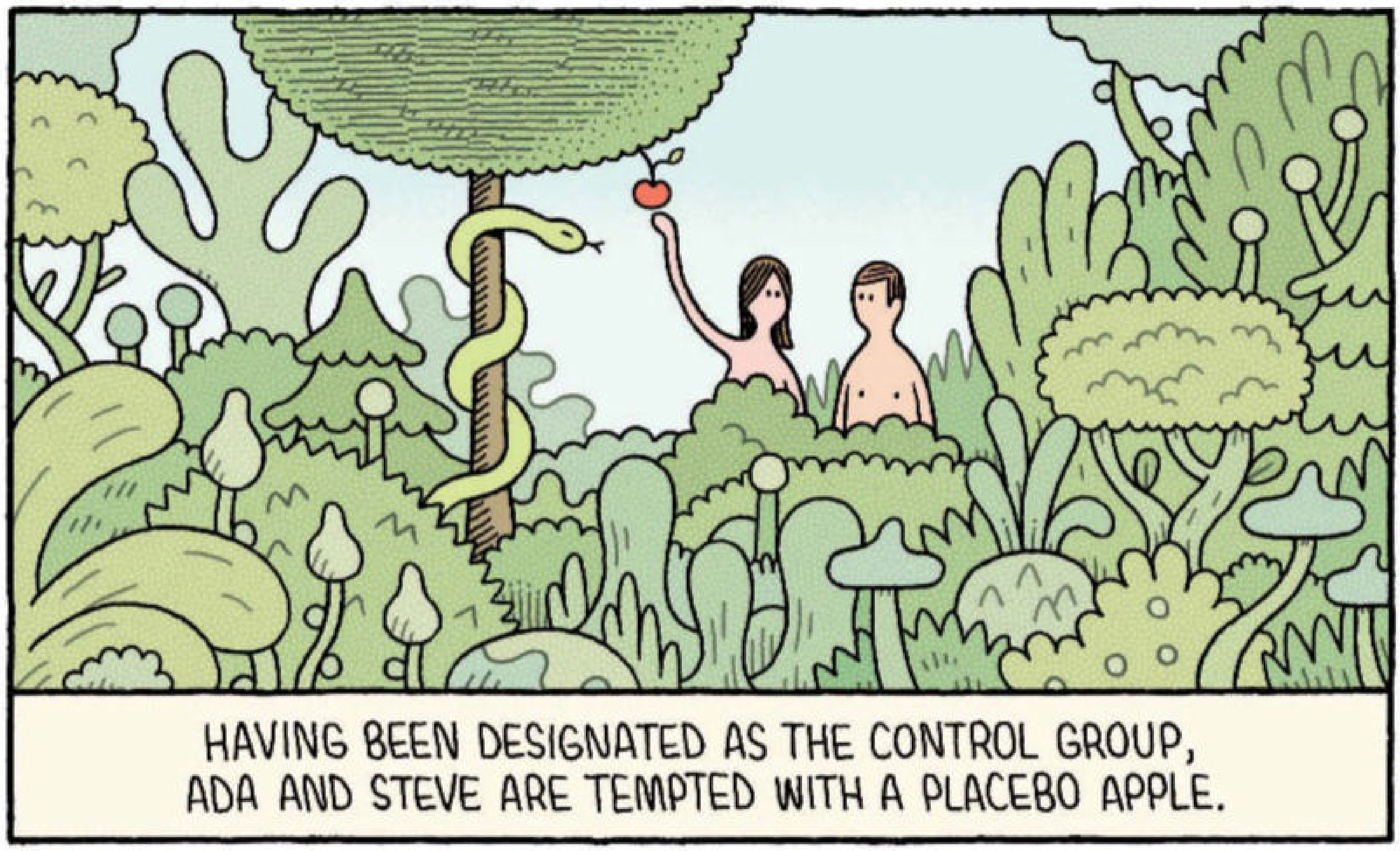
There are several possibilities. The most obvious is that we imagine the world as it is drawn on maps, where north is always up. Another, given that the questioner lives in Bexhill on the south coast of the UK, so will usually travel north, is that journeys away from home are often perceived as getting slower the further you go, which may be translated as more arduous and so more "uphill". This is because we have a greater density of familiar landmarks nearer to home, so the tempo at which they pass reduces as we get further away.

Related to this, the UK gets more rural, generally, as you go north and away from the London area, again producing a diminishing frequency of passing landmarks. Another point is that you may actually be going uphill, as the UK's topography contains higher hills the further north (and west) you travel.

These theories of uphill perception could all be tested. For example, with cultures that don't have north at the top of their maps, with you travelling further from home but westwards, with you travelling north from Bexhill to an urban centre like Birmingham, or with people in hilly mid-Wales travelling north to the Lancashire coast. I don't know if anyone has done this, though.

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Tom Gauld
for New Scientist



James Whalley
Quebec, Canada
I once saw a map of the world according to Australians, with Australia bang in the middle and Antarctica across the top. The reason your questioner feels that north is uphill and south is downhill is obvious. Like most of us, he has been indoctrinated from a young age with globes that have the North Pole at the top.

Driving north, you of course have to force the car up that steep slope towards the Arctic, while going south you can relax and enjoy a free and easy glide downhill to the equator.

Jon Williams
Ramsbottom, Lancashire, UK
As a cyclist living in the Pennine hills, I can assure you uphill feels as steep whether you are travelling north, south, east or west.

Hitting the right note

Most violinists use their left hand for intricate fingerwork, so why is the right hand used for more complex key pressing on the piano? (continued)

> **"Driving north, you have to force the car up that steep slope to the Arctic; going south, you can enjoy an easy glide to the equator"**

Keith Macpherson
Clevedon, Somerset, UK
The finesse required when playing musical instruments is probably the best example of handedness in humans. But there are other instances where you have to learn to do things the other way around.

Many people have experienced this reversal when having to drive in a foreign country. I experienced it when, after 14 years flying planes from the right-hand seat, I moved to the left. On the right, the gentler touch of my right hand on the control wheel contrasted with the coarser and stiffer response from the thrust levers manipulated by my left hand for controlling the engines. Moving to the left seat meant unlearning these biases in favour of new sensitivities.

Nervous passengers will be delighted to know this transition takes place in the simulator.

Marilyn Minchom Goldberg
London, UK
In 1997, Christopher Seed, a concert pianist who plays both normally and in mirror image, commissioned piano-makers Poletti and Tuinman to build him the world's first left-handed piano. The unconventional instrument received a lot of media interest and was exhibited at music festivals in Belgium and London.

Adrian Simper
Wasdale, Cumbria, UK
Most players will spend most of their time playing in ensembles, rather than as soloists. The carnage that would result from orchestral string players playing whichever way round they fancied doesn't bear thinking about. You have to be very confident of your future career as a soloist to not go with the crowd as a beginner.

Answers

Quick quiz #203 *Answers*

1 Four: the Hadean, Archean, Proterozoic and Phanerozoic
2 Eutrophication
3 Isidor Rabi
4 Group 16, the chalcogens
5 Coronal mass ejection

Quick crossword #133 *Answers*

ACROSS 1 Phosphorescent, **10** Gamed, **11** Red grouse, **12** Mitosis, **13** Imposed, **14** Chirp, **16** Interface, **19** Aggregate, **20** Noble, **22** Rhizome, **25** Thistle, **27** Radio mast, **28** Nurse, **29** White blood cell

DOWN 2 Hamstring, **3** Sides, **4** Hiroshima, **5** Radii, **6** Scrap iron, **7** Equus, **8** Treadle, **9** Agamic, **15** Pheromone, **17** Twenty-two, **18** Albuterol, **19** Aircrew, **21** Eleven, **23** Indri, **24** Email, **26** Ionic

#222 A question of balance *Solution*

More than 2 kilograms have been weighed.

We can say that the two arms have lengths A and B, and that the first portion of flour is F1 kg, while the second is F2 kg. $A \times F1 = B$, so $F1 = B / A$. On the other hand, $B \times F2 = A$, so $F2 = A / B$. So, the total mass is $F1 + F2 = B / A + A / B$.

Experimenting with some values of A and B should convince you that $F1 + F2$ is always > 2, but you can use algebra. Subtract 2 kg from the total and rearrange to get: $(A^2 + B^2 - 2AB) / AB = (A - B)^2 / AB$. Since A is a different length to B, $(A - B)^2 / AB$ must be > 0, so the total was over 2kg.

A spoonful of sugar?

Should one take sugar in one's tea? Feedback is mindful of two things about this question. For one, nearly everyone, in the UK especially, considers (or pretends to consider) the question to be of life-and-death importance; and secondly, they consider (or pretend to consider) one answer to be clearly correct.

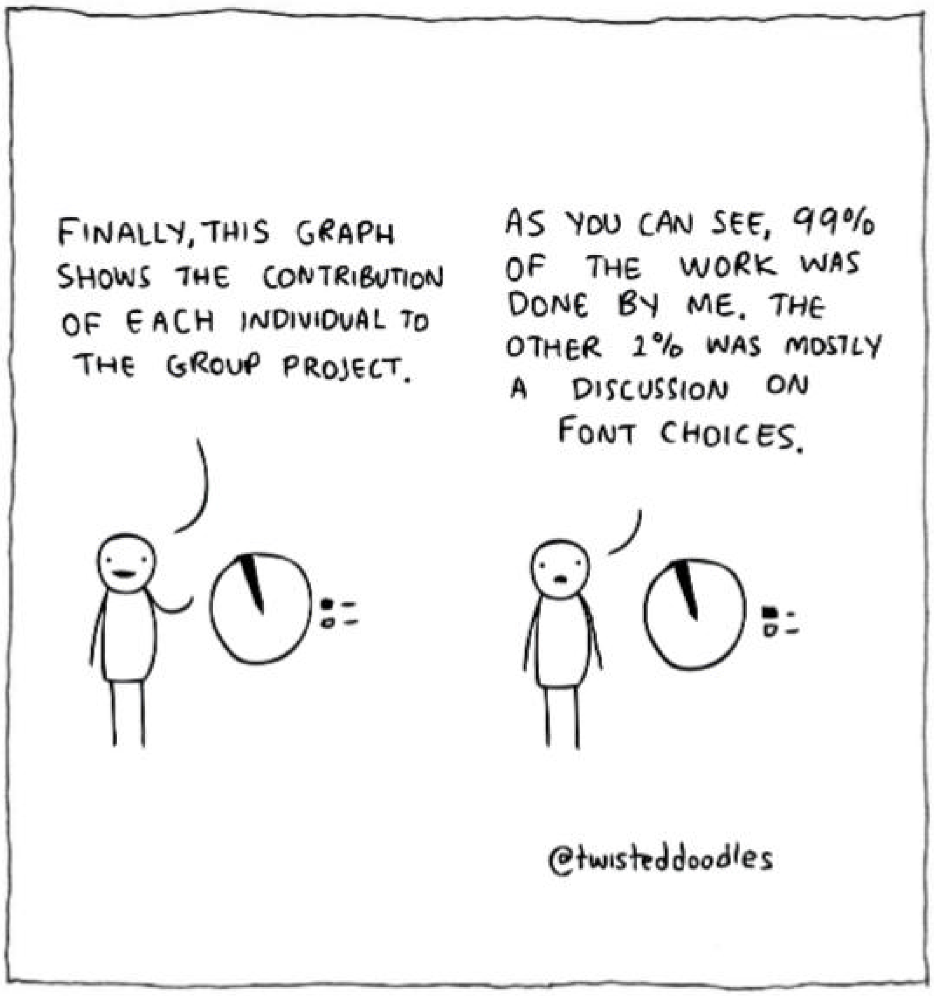
The *Annals of Internal Medicine* has published a 280-word item that – let's be blunt about this – throws a spanner in the teacup. A necessary and welcome spanner.

The item bears the headline "Correction: Tea consumption and all-cause and cause-specific mortality in the UK Biobank". It pertains to a study the journal published seven months earlier.

The key passage in the corrective is just 61 words long: "The Results section stated, 'Higher tea consumption was associated with lower risk for mortality regardless of whether sugar was added.' This has been changed to, 'Although higher tea consumption was associated with lower risk for mortality among those who did not report adding sugar to tea, the association between tea consumption and mortality was inconsistent when sugar was added to tea.'"

Feedback believes (or pretends to believe) that – after centuries of debate – this corrective answers the question so definitively and in a manner so un-understandable that everyone, of every opinion, can continue to enjoy being right (or pretending they are right).

Twisteddoodles *for New Scientist*



Got a story for Feedback?
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Consideration of items sent in the post will be delayed

Packaging philosophy

Mark Dionne tells Feedback of his surprise on learning that you can become a Doctor of Philosophy in packaging. It is Michigan State University's school of packaging that confers the necessary degree.

"We all have questions about packaging," reads its website, "such as, what is packaging and why is it important to society?" That statement is a little vague as to who, exactly, the "we" is.

One question we (whoever we are) might ask about packaging is: is there a paradigm for packaging?. In 1997, Hugh Lockhart, an instructor at the school of packaging, published what is still the best-known philosophical treatise on that question. Called "A paradigm for packaging", it spans 16 pages in the journal *Packaging Technology and Science*.

"It became necessary," writes Lockhart, "to find a name or descriptor for the model, other than A Paradigm for Packaging. The name that appeared and found favour with many of the faculty at the School of Packaging was Socio-Scientific Discipline."

Word spread. That name or descriptor found favour with other philosophers. Its fame endures, as shown in a 2022 essay by Babak Faraji at the University of Tehran and his colleagues, called "Application of biopolymer blends as edible films and coatings in food packaging", published in the book *Biodegradable Polymer-Based Food Packaging*. They mince no words. They beat around no bush. They state, plainly and unambiguously: "According to Lockhart (1997), packaging can be defined as a socio-scientific discipline."

Leftist food

The preference of Canadians as to which side of a bento (a traditional Japanese lunch comprising rice and vegetables with meat or fish, usually served in a lacquered box) should have the largest, most calorie-heavy component of the meal hadn't been determined – not with investigative rigour – until now.

Lisa Poon and Lorin Elias at the University of Saskatchewan presented 483 Canadians with a photo of a bento box and another of its mirror image. They published a report about it, called "What's in the box? Preference for leftward plating of food in bentos", in the journal *Food Quality and Preference*.

Citing earlier research by others, Poon and Elias say: "Japanese chefs traditionally plate their bentos with the most desirable or expensive food item in the upper left compartment, while the standard rice component is typically located in the bottom right section."

As is evident from the title of their paper, Poon and Elias found that most of the 483 Canadian bento box gazers, regardless of age, "preferred asymmetrical bentos where the majority of the food was plated on the left side of the box".

Poon and Elias also spotted an intriguing pattern that could inspire future research: "Irrespective of where the rice was placed, participants would usually prefer the version with a diagonal component arranged from a bottom left to top right angle." They report that this preference was evident "even when this angled aspect was as miniscule [sic] as a green onion garnish for decorative purposes".

Ex-superpowers

Rex Waygood adds two entries to Feedback's growing catalogue of trivial superpowers, along with a sad warning that some trivial superpowers can be temporary. He says: "I read about Trivial Superpowers and realised I had two. The first was the ability to take a handful of cereal, which I then weighed at 30 grams almost every time. I did this every morning to make breakfast. The second was to put my hand into a jar of almonds and extract 16 almonds almost without fail. However, since reading about the super powers, mine have disappeared. I'd like them back. How do I do that? I need to forget I ever read the article." ∎

Marc Abrahams

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